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HUMAN INFESTATIONS WITH ASCARIS AND TRICHURIS IN DIFFERENT PARTS OF THE PHILIPPINE ISLANDS

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FOUR TEXT FIGURES

Recently the writers made a quantitative survey of human intestinal parasites in different places in the Philippines in connection with an investigation on the anthelmintic efficiency of hexylresorcinol against *Ascaris lumbricoides, Trichuris trichiura,* and hookworms. The data obtained have been compiled and those on ascaris and trichuris are presented in this paper. Although there already exists a large volume of literature on the occurrence of these parasites in the Philippines, these available records are mostly in the form of incidence statistics. Recent surveys made in other parts of the world have shown that data of this sort do not portray accurately the true picture of parasitic infestations, for they do not distinguish between cases that are only slightly infested and those that are heavily parasitized. On the other hand, quantitative data, such as those obtained by the Stoll egg-counting technic, express the probable worm burden of an infested individual or of a population, for which reason they are considered more trustworthy and more useful in epidemiological surveys, especially in measuring the efficiency of treatments and control measures.

PLACES SURVEYED AND TIME OF YEAR

The bulk of our work was carried out in three places during different times of the year as follows: in Manila from July 25

to September 23, 1932; in Pardo, Cebu, from April 10 to 30, 1933; and in Paombong, Bulacan, from May 15 to June 3, 1933. It was planned to conduct the survey in more than one locality in order to find as great a variety of cases as possible for treatment with hexylresorcinol and at the same time to have an opportunity to determine some of the factors which might be involved in the distribution of intestinal parasites in the Philippines. The places mentioned were selected as representative of three distinct areas differing in social, sanitary, and economic development. Manila is a big city with a modern public-health service and represents, therefore, a typically urban environment. Pardo and Paombong, on the other hand, are rural communities lacking approved sanitary conveniences. The method of waste disposal in these two communities is primitive. As far as we were able to ascertain, in neither of the three places visited had there been conducted any worthwhile campaign against intestinal parasites during the last five years.

MATERIALS AND METHODS

The total number of persons examined was 1,393 distributed as follows: 503 in the City of Manila, 489 in Pardo, Cebu, and 401 in Paombong, Bulacan. Those examined in Manila were school children, 7 to 11 years of age and studying in the Magdalena Elementary School; those in Pardo and Paombong represented mixed populations.

Individual fæcal samples were collected in ordinary Petri dishes between two circular pieces of paraffined paper. The purpose of the latter was to facilitate the cleaning of the dishes. Uusally from forty to fifty of these containers were distributed in the afternoons and collected on the following mornings. As soon as the specimens were received in the laboratory, they were classified as to consistency and then prepared for egg-counting according to the displacement method of Stoll and Hausheer (1926). In recording the egg counts the figures were brought to the formed basis (Stoll, 1929) and corrected for size (Cort, Otto, and Spindler, 1930).

RESULTS OF EGG COUNTS FOR ASCARIS

For purposes of comparison the results of the fæcal examinations are given separately for each area surveyed. In Table 1 is shown the incidence of ascaris infestation and the egg counts analyzed according to age and sex.

Pardo, Cebu, Cebu.—Of the 489 persons examined 253 were males and 236 females. The males showed an ascaris incidence of 80.2 per cent and an average count of 15,960 eggs per cc of fæces. The incidence in the females was slightly lower, 78.8 per cent, but the average count was higher or 17,780 eggs per cc. The incidence in the entire Pardo series was thus 79.5 per cent and the average egg count 16,800 per cc. These figures, if corrected for a standard population according to the suggestion of Sweet (1929), would be as follows: the incidence in the males 80.7 per cent and the average egg count 14,750 per cc; the incidence in the females 79.5 per cent and the average egg count 17,250; the incidence in both sexes 78.1 per cent and the average count 16,000 per cc. Considering only the positive cases in order to indicate the intensity of the infestations, the averages were 20,200 eggs per cc in the two sexes, 18,400 in the males alone and 22,000 in the females. These are fairly high egg counts, the corrected figures indicating an average worm burden of 16 adult ascaris in the entire series of 489 individuals.[1] They approximate those obtained by Cort, Stoll, Riley, and Sweet (1929) in Panama, but our incidence percentages are much higher than those of the Panama series. They are also higher than most of the incidence percentages published by the earlier workers in the Philippines. Among the latter only Garrison, Leynes, and Llamas (1909) and Willets (1913) in surveys conducted in Taytay, Rizal, and in the Batanes Islands, respectively, reported incidences of ascaris infestations of a little over 79.5 per cent.

The characteristic distribution of ascaris in a mixed population is clearly shown in Table 1. When the individuals examined are classified into conventional age groups, the incidence of the parasite is much higher in younger than in older persons, the percentage of infestation being 95.9 per cent in the 196 individuals up to 14 years of age and only 68.5 per cent in the remaining 293 persons 15 years old and over. The same difference is observed between the two groups in regard to their egg counts, the average worm burden of the younger individuals being more

[1] From the egg counts the probable number of adult ascaris harbored by an individual may be estimated by dividing the number of eggs per cc. of stools by 1,000. In the use of this factor it is considered that the egg production per adult female ascaris is 2,000 per cc of fæces and the number of male and female worms approximately equal (Cort and Stoll, 1931).

TABLE 1.—*Results of egg counts for ascaris classified according to age and sex. The figures in parentheses represent the average counts of positive cases only.*

MALES.

Age group.	Pardo, Cebu. Cases.	Pardo, Cebu. Positive.	Pardo, Cebu. Incidence.	Pardo, Cebu. Average egg count per cc.	Paombong, Bulacan. Cases.	Paombong, Bulacan. Positive.	Paombong, Bulacan. Incidence.	Paombong, Bulacan. Average egg count per cc.	Manila. Cases.	Manila. Positive.	Manila. Incidence.	Manila. Average egg count per cc.
Years.			*P. ct.*				*P. ct.*				*P. ct.*	
0– 4	16	15	93.7	14,150 (15,100)	26	19	73.1	11,280 (15,430)	--------	--------	--------	--------
5– 9	44	42	95.4	23,680 (24,800)	34	34	100.0	23,990 (23,990)	166	137	82.5	26,340 (39,910)
10–14	46	45	97.8	35,230 (36,010)	19	17	89.5	44,230 (49,430)	93	80	86.0	31,320 (36,410)
15–19	23	18	78.2	12,000 (15,300)	10	8	80.0	21,600 (27,000)	--------	--------	--------	--------
20–24	29	19	65.5	6,510 (9,940)	17	14	82.3	8,330 (10,110)	--------	--------	--------	--------
25–29	27	18	66.6	5,700 (8,540)	25	15	60.0	5,780 (9,630)	--------	--------	--------	--------
30–34	11	9	81.8	8,750 (10,700)	16	10	62.5	10,020 (16,040)	--------	--------	--------	--------
35–39	17	12	70.6	6,930) (9,820)	7	4	57.1	8,260 (14,450)	--------	--------	--------	--------
40–44	10	5	50.0	3,880 (7,760)	16	6	37.5	6,120 (16,330)	--------	--------	--------	--------
45–49	11	7	63.6	15,000 (23,500)	6	5	83.3	15,870 (19,040)	--------	--------	--------	--------
50+	19	13	68.4	6,070 (8,880)	23	8	34.8	5,030 (14,460)	--------	--------	--------	--------
Total or average	253	203	80.2	15,960 (19,900)	199	140	70.3	14,960 (20,700)	259	217	83.8	28,090 (33,570)

FEMALES.

0– 4	18	17	94.4	15,400 (16,300)	19	15	78.9	18,610 (23,580)	--------	--------	--------	-----------
5– 9	29	29	100.0	32,700 (32,700)	23	22	95.6	23,790 (24,870)	155	131	84.5	25,710 (30,420)
10–14	43	40	93.0	28,350 (30,470)	29	26	89.6	22,880 (25,520)	89	77	86.5	36,530 (41,750)
15–19	23	16	69.6	15,100 (21,720)	28	23	82.1	20,410 (24,840)	--------	--------	--------	-----------
20–24	27	18	66.6	12,300 (18,400)	20	19	95.0	21,440 (22,570)	--------	--------	--------	-----------
25–29	25	19	76.0	12,900 (17,000)	20	14	70.0	7,930 (11,330)	--------	--------	--------	-----------
30–34	18	14	77.7	18,950 (24,370)	12	7	58.3	10,500 (18,000)	--------	--------	--------	-----------
35–39	13	9	69.2	10,680 (15,420)	13	8	61.5	8,680 (14,100)	--------	--------	--------	-----------
40–44	8	4	50.0	4,900 (9,800)	10	6	60.0	2,880 (4,800)	--------	--------	--------	-----------
45–49	8	4	50.0	17,350 (34,700)	4	2	50.0	2,900 (5,800)	--------	--------	--------	-----------
50+	24	16	66.6	3,780 (5,680	4	16	66.7	12,520 (18,770)	--------	--------	--------	-----------
Total or average	236	186	78.8	17,780 (22,560)	202	158	78.2	16,350 (21,300)	244	208	85.2	29,660 (34,790)

than twice that of the older ones. As a matter of record the highest individual counts in the two sexes were 137,600 and 160,800 eggs per cc and were met with in a boy 10 years old and in a girl 11 years old, respectively.

A comparison of the counts of the different age groups is shown graphically in text figure 1. In the males the average

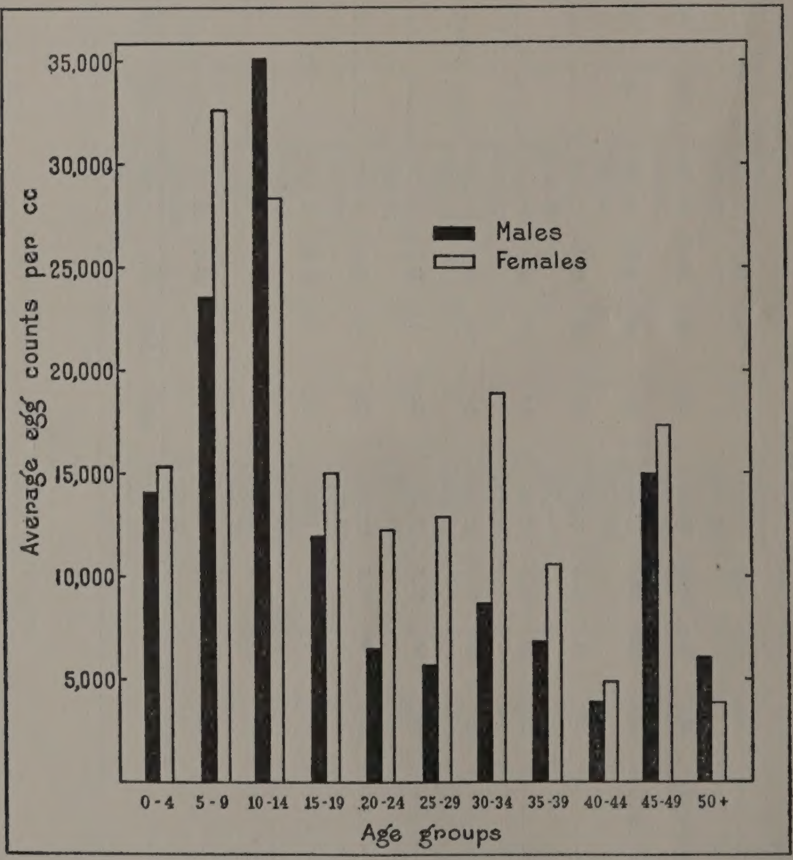

FIG. 1. Showing average ascaris egg counts of Pardo series. See Table 1.

count of 14,150 eggs per cc in the group 0 to 4 years old is comparatively high, but the counts are much higher in the next two groups, the peak of the egg count curve occurring in the 10- to 14-year group and representing an average of 35,230 eggs per cc. The curve then falls abruptly in the 15- to 19-year group and continues to fall in the succeeding age groups with no tendency to rise except in the 45- to 49-year group. In the fe-

male series the average counts are also high in the younger groups, the peak of the curve occurring in the 5- to 9-year group and representing 32,700 eggs per cc. In the 10- to 14-year group the curve drops slightly to 28,350 eggs per cc. Then there is a sudden drop to 15,100 in the 15- to 19-year group, but in contrast to what has been observed in the males, the curve is maintained more or less at that level in the succeeding groups, except in the 40- to 44- and 50-year and over groups. The average egg count of females over 15 years old is about twice that of males of the same age.

TABLE 2.—*Ascaris infestations of Pardo series classified according to intensity groups.*

MALES.

Ascaris infestation groups in eggs per cc.	Ages 0–14 yrs.		Ages 15–29 yrs.		Ages 30–44 yrs.		Ages 45+yrs.		All ages.	
		P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*
Negative	4	3.8	24	30.4	12	31.6	10	33.3	50	19.8
1–10,000	36	33.9	37	46.9	19	50.0	13	43.3	105	41.5
10,001–50,000	48	45.3	16	20.2	6	15.8	5	16.7	75	29.6
50,001–100,000	13	12.3	2	2.5	1	2.6	2	6.7	18	7.1
100,001+	5	4.7	0	-------	0	0	0	0	5	2.0
Total	106	100.0	79	100.0	38	100.0	30	100.0	253	100.0

FEMALES.

Ascaris infestation groups in eggs per cc.	Ages 0–14 yrs.		Ages 15–29 yrs.		Ages 30–44 yrs.		Ages 45+yrs.		All ages.	
Negative	4	4.4	22	29.3	12	30.8	12	37.5	50	21.2
1–10,000	32	35.6	25	33.3	14	35.9	15	46.9	86	36.4
10,001–50,000	36	40.0	24	32.0	10	25.6	4	12.5	74	31.4
50,001–100,000	15	16.7	3	4.0	2	5.1	0	-------	20	8.5
100,001+	3	3.3	1	1.3	1	2.6	1	3.1	6	2.5
Total	90	100.0	75	99.9	39	100.0	32	100.0	236	100.0

In Table 2 an analysis of the individual infestations into intensity groups is given. Here again the same differences already noted in the distribution of ascaris in a mixed population are evident. In the first place it is shown that about 60 per cent of all the persons examined, 73 per cent of those at least 15 years of age, and only 38 per cent of those up to 14 years old, fall in the negative and lowest egg count groups, in which the estimated number of adult worms harbored is not more than 10. On the other hand, there were 49 cases in the highest egg count groups, that is, those with more than 50,000 eggs per cc, of which 36 or 73 per cent were met with in young individuals up to 14 years old. These 36 cases represent only

about 7.4 per cent of the 489 persons examined, but the sum of their egg counts constitutes 60 per cent of that of the entire series. Considering the sexes separately, of the males 7.1 per cent, all of them young, carry 55 per cent of the total worm burden of the males and of the females 7.6 per cent carry 62 per cent of the total count of the females. These findings are in accord with those of other workers who observed that there is a tendency in ascaris infestation for a large percentage of the worm burden to be concentrated in a small number of individuals. This, according to Cort (1931), is due to the fact that a combination of factors, such as, grossly polluted sources of infestation and very poor personal hygiene which are necessary to produce very heavy infestations, are rarely met with. The explanation given for the greater prevalence of the parasite in children is that the latter are more exposed to infestation on account of their playing on the ground and of their generally more insanitary habits.[2] Women of child-bearing age have also greater chances of being infested than adult males due to their closer association with children and to the greater proportion of time that they spend in and around the house. Curiously enough in our series the average count of women of child-bearing age is very similar to that of children between 0 and 4 years old.

Paombong, Bulacan.—As shown in Table 1, of the 401 individuals who were egg-counted in this town, 74.3 per cent were found positive for ascaris, the percentage being 70.3 per cent in the 199 males and 78.2 per cent in the 202 females. As in the Pardo series, the incidence was higher in the younger individuals, the infestation among 150 persons up to 14 years of age being 88.7 per cent and only 65.7 per cent among the 251 persons 15 years old and over. The average egg count of the entire series is 15,860 per cc, being 14,960 for the males and 16,350 for the females. These figures, if corrected for a standard population, would be 16,300 for both males and females, 16,800 for the males alone and 15,750 for the females. If the positive cases alone are considered, the average count of

[2] We have inquired into the possible sources of ascaris and trichuris infestations in Manila and Paombong by examining soil samples and other suspected objects for the embryonated ova of the two parasites according to the method of Caldwell and Caldwell, as described by Spindler (1929). Our findings conform with those of Brown (1927) and Otto, Cort, and Keller (1931) in that they point to soil pollution in the immediate surroundings of houses as the chief source of infestation.

the two sexes is 21,050, of the males alone 20,700 and of the females 21,300. In both males and females the average counts are comparatively high in the younger individuals, the peak of the average egg count curve occurring between 10 and 14 years in the males and between 5 and 9 years in the females. In the males the average counts become gradually smaller from the 15th year on; while in the females they are conspicuously high between 15 and 24 years, after which the curve is maintained at a low level as in the males.

TABLE 3.—*Ascaris infestations of Paombong series classified according to intensity groups.*

MALES.

Ascaris infestation groups in eggs per cc.	Ages 0–14 yrs.		Ages 15–29 yrs.		Ages 30–44 yrs.		Ages 45+yrs.		All ages.	
		P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*
Negative	9	11.4	15	28.8	19	48.7	16	55.2	59	29.7
1–10,000	22	27.8	21	40.4	12	30.8	7	24.1	62	31.1
10,001–50,000	41	51.9	15	28.8	5	12.8	5	17.2	66	33.2
50,001–100,000	4	5.1	1	1.9	3	7.7	1	3.5	9	4.5
100,001+	3	3.8	0	-------	0	-------	0	-------	3	1.5
Total	79	100.0	52	99.9	39	100.0	29	100.0	199	100.0
FEMALES.										
Negative	8	11.3	12	17.6	14	40.0	10	35.7	44	21.8
1–10,000	27	38.0	28	41.2	10	28.6	9	32.1	74	36.6
10,001–50,000	29	40.8	20	29.4	11	31.4	7	25.0	67	33.2
50,001–100,000	4	5.7	8	11.8	0	-------	1	3.6	13	6.4
100,001+	3	4.2	0	-------	0	-------	1	3.6	4	2.0
Total	71	100.0	68	100.0	35	100.0	28	100.0	202	100.0

An analysis of the egg counts into intensity groups, as given in Table 3, shows that 59.6 per cent of all individuals examined, 68.9 per cent of those at least 15 years of age, and only 44 per cent of those between 0 and 14 years old, were found to be either free from ascaris or to have an average worm burden estimated to be not more than 10 adult parasites. As in the Pardo series, the greater bulk of the infestation was found concentrated in a few individuals (29 cases), 48.2 per cent of whom were young persons not over 14 years of age. These 29 cases constitute only 7.2 per cent of the 401 persons examined, but their total egg count represents more than 40 per cent of that of the entire series.

Manila.—As shown in Table 1, of the 503 school children examined in Manila 84.5 per cent were positive for ascaris, the

incidence being 83.8 per cent in the 259 boys and 85.2 per cent in the 244 girls. The average count of the entire series was 28,870, of the boys alone 28,090, and of the girls 29,660 eggs per cc of fæces. Considering only the positive cases, the average counts were 34,180 in both sexes, 33,570 in the males and 34,790 in the females.

TABLE 4.—*Ascaris infestation in 503 school children (ages 7 to 11 years) in Manila, arranged according to intensity groups.*

Ascaris infestation group in eggs per cc.	Males.		Females.	
		Per cent.		*Per cent.*
Negative	42	16.2	36	14.7
1–10,000	65	25.1	58	23.8
10,001–50,000	104	40.2	102	41.8
50,001–100,000	30	11.6	37	15.2
100,001+	18	6.9	11	4.5
Total	259	100.0	244	100.0

An analysis of the counts into intensity groups, as given in Table 4, shows that about 40 per cent of all the children examined belonged to the negative and lowest egg-count groups and only 19 per cent to the highest egg-count groups. The total count of the latter represents nearly 60 per cent of that of the entire group. Considering the sexes separately, 18.5 per cent of the boys had 58 per cent of the total count of all of the boys and 19.7 per cent of the girls had 59 per cent of the count of all of the girls. These figures show that even in a series composed entirely of school children there is a tendency for the greater bulk of the infestation to be concentrated in a limited number of individuals.

RESULTS OF EGG COUNTS FOR TRICHURIS

The data available for the study of trichuris infestation represent the results of the examination of the same individuals from which the ascaris counts were obtained. As in the case of the latter, they are given separately according to population groups for purposes of comparison (Table 5).

Pardo, Cebu, Cebu.—Of the 489 persons examined 431, or 88.1 per cent, were positive for trichuris, the incidences in the males and in the females being exactly the same. The average egg count of the entire series was 4,400, of the males alone 4,120, and of the females 4,630. These data would be as follows, if corrected for a standard population: Incidence in the

entire series 87.7 per cent, in the males alone 86.8 per cent, and in the females 88.6 per cent; egg count of the entire series 3,900, of the males alone 3,500, and of the females 4,300. Considering only the positive cases the average counts were 4,970 in the two sexes, 4,680 in the males and 5,260 in the females.

It will be noticed from the data presented in Table 5 that with the exception of the males between 30 and 34 years the

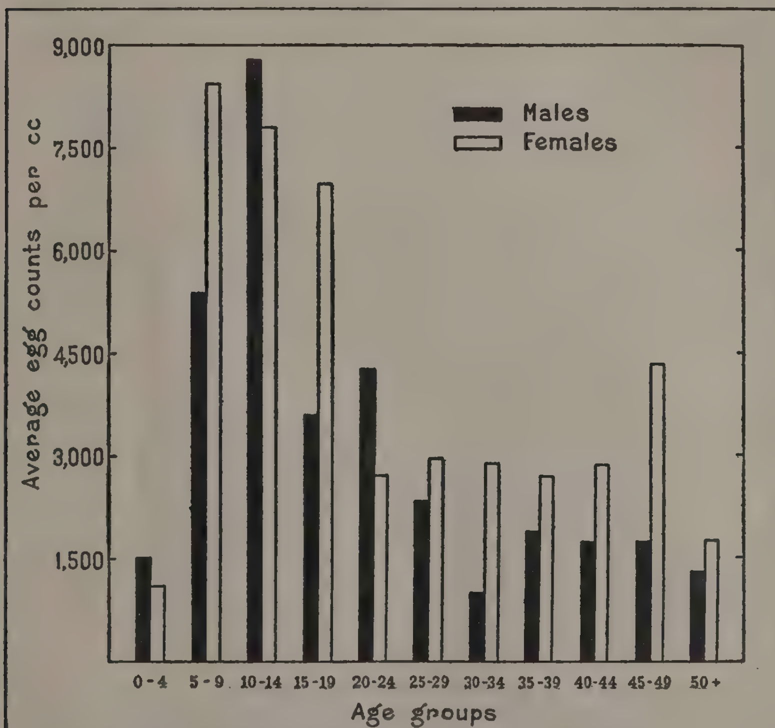

FIG. 2. Showing average trichuris egg counts of Pardo series. See Table 5.

incidence of trichuris in the various age groups is uniformly high, the differences occurring between the younger and older individuals not being as significant as those observed in ascaris infestations. With respect to the average egg counts, however, the same age and sex differences as were encountered in ascaris infestations are evident (text fig. 2). In both sexes the egg counts were low in young children between 0 and 4 years, the peak of the egg count curve in the males occurring between 10 and 14 years and in the females between 5 and 9 years. In

TABLE 5.—*Results of egg counts for trichuris classified according to age and sex. The figures in parentheses represent the average counts of positive cases only.*

MALES.

Age group.	Pardo, Cebu.				Paombong, Bulacan.				Manila.			
	Cases.	Positive.	Inci-dence.	Average egg count per cc.	Cases.	Positive.	Inci-dence.	Average egg count per cc.	Cases.	Positive.	Inci-dence.	Average egg count per cc.
Years.			*P. ct.*				*P. ct.*				*P. ct.*	
0–4	16	14	87.5	1,520 (1,730)	26	10	38.5	230 (600)				
5–9	44	43	97.7	5,370 (5,500)	34	26	76.5	1,380 (1,810)	166	144	86.7	2,400 (2,770)
10–14	46	46	100.0	8,800 (8,800)	19	12	63.2	2,000 (3,170)	93	83	89.2	4,200 (4,700)
15–19	23	21	91.3	3,600 (3,940)	10	5	50.0	1,560 (3,120)				
20–24	29	24	82.7	4,280 (5,170)	17	12	70.6	1,010 (1,430)				
25–29	27	20	74.1	2,340 (3,160)	25	13	52.0	690 (1,380)				
30–34	11	6	54.5	1,020 (1,870)	16	9	56.3	770 (1,380)				
35–39	17	15	88.2	1,900 (2,160)	7	5	71.4	1,140 (1,600)				
40–44	10	8	80.0	1,740 (2,170)	16	10	62.5	820 (1,320)				
45–49	11	10	90.9	1,760 (1,940)	6	5	83.3	1,000 (1,200)				
50+	19	16	84.2	1,340 (1,500)	23	11	47.8	450 (940)				
Total or average	253	223	88.1	4,120 (4,680)	199	118	59.3	960 (1,620)	259	227	87.6	3,040 (3,480)

FEMALES.

0– 4	18	16	88.8	1,100 (1,240)	19	10	52.6	320 (600)				
5– 9	29	28	96.5	8,450 (8,750)	23	21	91.3	1,230 (1,350)	155	131	84.5	2,680 (3,170)
10–14	43	38	88.4	7,820 (8,850)	29	16	55.2	1,250 (2,270)	89	81	91.0	3,050 (3,360)
15–19	23	18	78.3	7,000 (8,890)	28	21	75.0	1,850 (2,470)				
20–24	27	24	88.8	2,720 (3,060)	20	10	50.0	660 (1,320)				
25–29	25	19	76.0	2,970 (3,900)	20	6	30.0	160 (540)				
30–34	18	15	83.3	2,910 (3,360)	12	5	41.7	330 (800)				
35–39	13	13	100.0	2,710 (2,710)	13	6	46.1	310 (670)				
40–44	8	8	100.0	2,900 (2,900)	10	5	50.0	400 (800)				
45–49	8	8	100.0	4,350 (4,350)	4	2	50.0	300 (600)				
50+	24	21	87.5	1,780 (1,990)	24	14	58.3	570 (970)				
Total or average	236	208	88.1	4,630 (5,260)	202	116	57.4	820 (1,430)	244	212	86.9	2,810 (3,240)

the males there is observed a marked reduction after the fourteenth year while in the females the drop occurs at least five years later. A comparison of the egg counts of adult individuals shows that the trichuris burden of the females is nearly twice as great as that of the males. These differences are most probably due to the same factors which have been mentioned as responsible for the distribution of ascaris in a mixed population, considering that both parasites have simple life cycles and identical modes of transmission.

TABLE 6.—*Trichuris infestations of Pardo series classified according to intensity groups.*

MALES.

Trichuris infestation group in eggs per cc.	Ages 0–14 yrs.		Ages 15–29 yrs.		Ages 30–44 yrs.		Ages 45+yrs.		All ages.	
		P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*
Negative	3	2.8	14	17.7	9	23.7	4	13.3	30	11.9
1–1,000	19	17.9	21	26.6	13	34.2	9	30.0	62	24.5
1,001–2,500	18	17.0	18	22.8	9	23.7	14	46.7	59	23.3
2,501–5,000	22	20.8	8	10.1	3	7.9	1	3.3	34	13.4
5,001+	44	41.5	18	22.8	4	10.5	2	6.7	68	26.9
Total	106	100.0	79	100.0	38	100.0	30	100.0	253	100.0
FEMALES.										
Negative	8	8.9	14	18.7	3	7.7	3	9.4	28	11.9
1–1,000	15	16.7	15	20.0	5	12.8	11	34.4	46	19.5
1,001–2,500	18	20.0	13	17.3	16	41.0	6	18.7	53	22.4
2,501–5,000	13	14.4	13	17.3	8	20.5	8	25.0	42	17.8
5,001+	36	40.0	20	26.7	7	18.0	4	12.5	67	28.4
Total	90	100.0	75	100.0	39	100.0	32	100.0	236	100.0

An analysis of the individual infestations into intensity groups, as given in Table 6, shows that 34 per cent of all the persons examined, 23 per cent of those between 0 and 14 years of age, and 61.7 per cent of those 15 years old and over, were either free from trichuris or only very slightly infested, as judged by their egg counts which were not more than 1,000 per cc of stools. In the heavily infested groups, that is, those with counts of more than 2,500 eggs per cc, there were 211 cases, of which 115 or 54.5 per cent were young individuals up to 14 years of age. These 115 cases had a total count representing 66 per cent of that of the entire series; but since they constitute 23.5 per cent of all the persons examined, it is shown that in trichuris infestations the tendency which has been observed in

ascaris infestations for the bulk of the worm burden to be concentrated in a small number of persons, does not occur. The highest individual counts were 56,000 and 60,000 in a 20-year-old male and in a 13-year-old female, respectively.

Paombong, Bulacan.—Of the 401 persons examined in this town 234, or 58.1 per cent, were positive for trichuris, the incidence in the 199 males being 59.3 per cent and in the 202 females 57.4 per cent. The average egg count of the entire series was 890, of the males alone 960, and of the females 820. These data would be as follows, if corrected for a standard population: Incidence in the entire series 58.4 per cent, in the males alone 59.3 per cent, and in the females 57.5 per cent; egg count of the entire series 890, of the males alone 1,020, and of the females 760. These are low averages compared with those of the Pardo series and seem to indicate that there are certain factors existing in Paombong, Bulacan, which operate against the development of heavy trichuris infestations.

TABLE 7.—*Trichuris infestations of Paombong series classified according to intensity groups.*

MALES.

Trichuris infestation group in eggs per cc.	Ages 0–14 yrs.		Ages 15–29 yrs.		Ages 30–44 yrs.		Ages 45+yrs.		All ages.	
		P. ct.		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*
Negative	31	39.2	22	42.3	15	38.4	13	44.8	81	40.7
1–1,000	26	32.9	15	28.8	12	30.8	10	34.5	63	31.7
1,001–2,500	8	10.1	11	21.2	10	25.6	5	17.2	34	17.1
2,501–5,000	10	12.7	1	1.9	1	2.6	1	3.5	13	6.5
5,001+	4	5.1	3	5.8	1	2.6	0		8	4.0
Total	79	100.0	52	100.0	39	100.0	29	100.0	199	100.0
FEMALES.										
Negative	24	33.8	31	45.6	19	54.3	12	42.8	86	42.6
1–1,000	27	38.0	24	35.3	12	34.3	11	39.3	74	36.6
1,001–2,500	11	15.5	5	7.3	4	11.4	5	17.9	25	12.4
2,501–5,000	6	8.5	5	7.3	0		0		11	5.4
5,001+	3	4.2	3	4.4	0		0		6	3.0
Total	71	100.0	68	99.9	35	100.0	28	100.0	202	100.0

An analysis of the individual counts into intensity groups, as given in Table 7, shows that nearly 76 per cent of the whole series belong to the negative and lowest egg count groups and only 9.5 per cent to the highest egg count groups. In the latter most of the counts were between 3,000 and 6,000, the only ex-

ceptions being the counts of 8,000 and 17,600 in a 10-year-old male and in a 19-year-old female, respectively.

Manila.—Of the 503 children examined, 439 or 87.3 per cent were positive for trichuris, the percentage in the 259 boys being 87.6 per cent and in the 244 girls 86.9 per cent. The average egg count of the entire series was 2,940, of the males alone 3,040, and of the females 2,810. If only the positive cases are considered, the average count of the whole group was 3,360, of the boys 3,480, and of the girls 3,240. An analysis of the counts into intensity groups, as given in Table 8, shows that 218 children, or 43 per cent, were either free from trichuris or only lightly infested with counts not exceeding 1,000 per cc of fæces and that 170 cases, or 34 per cent, were either moderately or heavily parasitized each with a count of more than 2,500 eggs per cc. The combined count of the latter constitutes nearly 80 per cent of that of the entire group, showing that in this, as in the Pardo series, the bulk of the infestation is not concentrated in such a small number of individuals as was found to be the case in ascaris infestation. The highest individual counts were 73,000 and 19,200 in a boy 11 years old and in a girl 12 years old, respectively.

TABLE 8.—*Trichuris infestation in 503 school children (ages 7 to 11 years) in Manila, arranged according to intensity groups.*

Trichuris infestation group in eggs per cc.	Males.		Females.	
		Per cent.		*Per cent.*
Negative	32	12.4	32	13.1
1–1,000	84	32.4	70	28.7
1,001–2,500	61	23.5	54	22.1
2,501–5,000	36	13.9	46	18.9
5,001+	46	17.8	42	17.2
Total	259	100.0	244	100.0

COMPARISON OF THE ASCARIS AND TRICHURIS INFESTATIONS OF THE THREE POPULATION GROUPS EXAMINED

One would expect, as in fact it has been claimed due to apparently favorable climatic conditions, the distribution in the Philippines, especially in the unsanitated rural districts, of the common intestinal worms of man to be more or less uniform. Some of the earlier workers in tropical medicine in the Islands, however, must have suspected that such is not the case, for a number of them conducted surveys in widely separated places, obviously to learn something of the local geographical distribu-

tion of these parasites. Unfortunately very little progress in this direction was made, solely because of the fact that the apparently more accurate methods of field investigation which are now available were then unknown. Willets (1914) in particular examined cases from practically every province in the Archipelago, but the data he collected were only incidence statistics, from which he was unable to draw worthwhile conclusions. He merely noted that the distribution of the various intestinal parasites was extremely irregular, that in many instances very different results were obtained from adjacent northern and adjacent southern provinces.

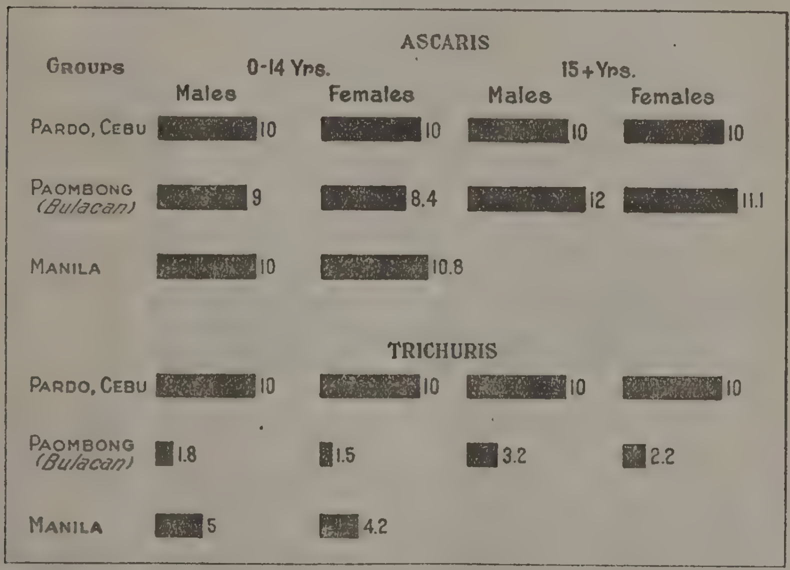

FIG. 3. Comparing the egg counts for ascaris and trichuris of the Pardo series with those of the Manila and Paombong series.

As stated in an earlier section of this paper, it has been shown by recent investigations that for epidemiological purposes quantitative data based on the egg output of intestinal worms are more accurate than incidence statistics. This being the case, a comparison of our three sets of egg counts for ascaris and trichuris with each other should give more valuable information regarding the distribution of these parasites in the Philippines. Such a comparison is shown in text figure 3, in which the average counts for the two parasites of children (0 to 14 years old) and adults (15 years and over) in the Pardo series,

classified according to sex, are each given a weight of 10 and the ratio to this figure of each of the corresponding counts in the Manila and Paombong series is calculated. It is evident from the bar diagrams that in the case of ascaris there are not very noticeable differences in the distribution of the parasite, the degree of infestation being about the same in the three groups. It is true that in the Paombong series the children show a slightly smaller worm burden, but the deficiency is made up by the somewhat higher counts of the adults. In the case of trichuris the differences are very marked, the average worm burden of those from Pardo being nearly five times as heavy as that of the Paombong group and about twice that of the Manila series. The significance of these observations is that in the three places where the examinations were conducted the conditions were equally favorable for the propagation of ascaris while the factors favoring the dissemination of trichuris were present to a greater extent in Pardo than in either Manila or Paombong.

To explain this difference in the distribution of the two parasites, reference should be made to the recent studies by Spindler (1929) and Otto (1929) on the biology of the eggs of these worms. According to these authors the ova of ascaris and trichuris are both resistant to many external conditions, but with the difference that the ova of trichuris are more easily destroyed by dessication and require more moisture for development than those of ascaris. It is suggested that this difference is probably the main reason why ascaris is so widely prevalent in different parts of the world while trichuris is mostly limited to those warm places where the soil is damp during the greater part of the year. The prevalence of ascaris in the Philippines could be explained in a similar manner, but to what extent the question of moisture enters as a factor in the local distribution of trichuris can only be determined by considering the amount and distribution of the annual rainfall and the effect of the shade of trees and other vegetation on the conservation of ground moisture. According to Father Coronas (1920) the monthly distribution of the annual rainfall in the Philippines may be classified into four types as follows: first type, in which there are two pronounced seasons—dry in winter and spring and wet in summer and autumm; second type, in which there is no dry season, with a very pronounced rain period in winter; third or intermediate A type, in which there is no very pronounced

rain period, with a short dry season lasting only for one to three months; fourth or intermediate B type, in which there is no very pronounced rain period and no dry season. Manila and Paombong are included among the regions having the first type and Pardo among those having the third type of rainfall distribution. Text figure 4 shows that although the annual rainfall of Pardo (1,530 mm) is less than that of either Manila (1,963 mm) or Paombong (2,103 mm)[3], it is more evenly distributed between the different months. Besides, there is in Pardo an abundance of coconut trees, especially around the houses, in contrast to the sparse vegetation in Manila and Paombong.

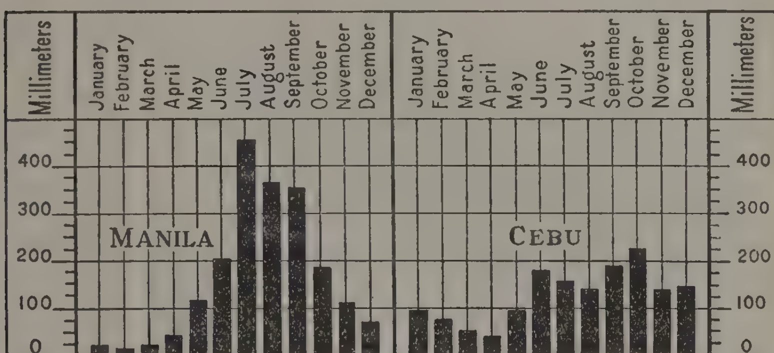

FIG. 4. Showing the monthly distribution of rainfall in Manila and Cebu. (From Coronas in the 1918 Census of the Philippine Islands.)

These factors taken together suggest a more uniform moisture content in the soil at Pardo, while in the other two places the soil is either too wet or too dry depending upon the time of the year. In other words there is in the former locality sufficient moisture throughout or during the greater part of the year for the development of trichuris eggs, while in Manila and Paombong the ground is so dry during certain months that trichuris ova are destroyed. For this reason the danger of building up heavy trichuris infestations is greater in Pardo than in the other two places.

[3] These data on annual rainfall are taken from the 1918 Census of the Philippine Islands. The information for Pardo is judged from the records of the climatological station at Cebu, which is about 6 kilometers from Pardo, that for Paombong from the records of the station at Marilao, which is about 22 kilometers from Paombong.

SIGNIFICANCE OF ASCARIS COUNTS OF CHILDREN IN MANILA

It was noted above that the egg counts for ascaris of children in Manila were as high as those of children in Pardo and Paombong, indicating the presence in these three places of sources of infestation to which the people are exposed. This finding calls for some comment in view of the fact that Manila with its modern system of waste disposal should possess certain sanitary advantages over Pardo and Paombong, which are not as well sanitated. The inference, therefore, is that not all of the members of the community in Manila take advantage of the available sanitary facilities, as otherwise soil pollution could not occur and the propagation of the parasite could not take place to the extent suggested by the high egg counts (see footnote 2 on page 98). In this connection our observations made in some of the poorer and more crowded sections of the city, where the large majority of the children examined reside, have shown that, as in most other places where ascariasis prevails, it is the children, especially those of preschool age, who are mainly responsible for the pollution of the ground. And since it has been shown that it is the children who are most subject to ascariasis, the conclusion is that they are mostly responsible for the spread of the parasite. For this reason, as pointed out by Cort (1933), in any campaign against ascariasis, if successful results are to be expected, special efforts must be exerted to control the promiscuous defecation of young children.

SUMMARY

A quantitative parasitological survey by means of the Stoll egg counting technic was conducted in three different places in the Philippine Islands in connection with an investigation on the anthelmintic efficiency of hexylresorcinol against the common intestinal worms of man. A total of 1,393 persons were examined, distributed as follows: 489 in Pardo, Cebu, Cebu; 401 in Paombong, Bulacan, Luzon; and 503 in the City of Manila. Those from Pardo and Paombong were mixed populations, while those from Manila were school children 7 to 11 years old.

The results of the egg counts for ascaris were as follows: Pardo series, incidence 79.5 per cent, average count 16,800 eggs per cc of fæces; Paombong series, incidence 74.3 per cent, average egg count 15,860; Manila series, incidence 84.5 per cent, average egg count 28,870.

The results of the egg counts for trichuris were as follows: Pardo series, incidence 88.1 per cent, average egg count 4,400; Paombong series, incidence 58.1 per cent, average egg count 890; Manila series, 87.3 per cent, average egg count 2,940.

An analysis of the counts for ascaris showed that in a mixed population the incidence is higher and the degree of infestation heavier in children (0 to 14 years old) than in adults (15 years old and over), that it is more prevalent and heavier in females of child-bearing age than in males of corresponding age, and that the greater bulk of the worm burden is concentrated in a small percentage of individuals, most of whom are children.

An analysis of the counts for trichuris showed that the parasite has practically the same age and sex distribution in a mixed population as ascaris, but the worm burden was more evenly distributed than in ascaris infestation.

A comparison of the three sets of count with each other showed no important differences in the intensity of ascaris in the three places where the survey was conducted, while in the case of trichuris the infestations were decidedly heavier in those from Pardo than in those from either Manila or Paombong. This difference in the distribution of the two parasites is ascribed to the difference in the resistance of their eggs. The ova of ascaris are resistant to many unfavorable external conditions, for which reason the parasite is very widely distributed. The ova of trichuris are easily destroyed by dessication, for which reason the danger of contracting heavy infestations with the parasite is greater in regions where, due to the distribution of the annual rainfall and the presence of covering vegetation, the ground is damp during the greater part of the year.

It was determined that ascaris infestation in the Philippines is due to soil pollution around the houses. In view of this, the high incidence and intensity of the parasite in Manila, where there is a modern system of waste disposal, is taken as an indication that not all of the members of the community utilize the available sanitary facilities. Observations made in some of the poorer and more crowded sections of the city, where the majority of the children examined reside, showed that it is the children of preschool age who are mainly responsible for the pollution of the soil. For this reason in any campaign against ascaris, in order to produce successful results, special efforts should be exerted to control the promiscuous defecation of children.

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ILLUSTRATIONS

TEXT FIGURES

NEMATODES IN THE COLLECTION OF THE PHILIPPINE BUREAU OF SCIENCE, II: FILARIOIDEA

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FOUR PLATES

The nematode superfamily Filarioidea comprises an interesting group of parasites, of which the following species have already been reported from the Philippines: *Wuchereria bancrofti* of man, *Dirofilaria immitis* of dogs, *Setaria equina* of horses, *S. labiato-papillosa* of cattle, *Elæophora poeli* of cattle and carabaos, and *Diplotriæna corrugata* of the bird *Ptilocichla basilanica*. In the present paper are described six new members of the group, one of which was collected from cattle and the rest from birds. I wish to thank Dr. Zacarias de Jesus, of the Philippine Bureau of Animal Industry, for presenting the parasite from cattle, and Miss Victoria A. Masiluñgan, of the Bureau of Science, for much technical assistance.

Family FILARIIDÆ (Cobbold, 1864) Claus, 1885

Subfamily FILARIINÆ Stiles, 1907

PARAFILARIA BOVICOLA sp. nov. Plate 1, figs. 1 to 3.

Several specimens of this filaria were collected by Doctor Zacarias de Jesus, of the Bureau of Animal Industry, from native cattle presenting skin lesions that answer the description of those reported in horses and which are associated with a parasite very closely related to *Parafilaria multipapillosa* (Condamine and Drouilly, 1878). Only two of the specimens are complete for purposes of description and both are females. Doctor de Jesus, who is interested in the parasite from the pathological standpoint, has under observation an infested animal; if he should succeed in recovering male worms, a more complete description of the nematode than is given below will be forthcoming.

A comparison of the material at hand with the female of *Parafilaria multipapillosa*, as described by Railliet and Moussu (1892) and as figured by Yorke and Maplestone (1926), has

brought out the following differences: the eggs of the Philippine species as well as the inclosed embryos are smaller and the cuticular adornment at its anterior end appears quite distinct in that the papillalike structures behind the mouth that are characteristically numerous in *P. multipapillosa* are limited in number, there being more transverse cuticular prominences or ridges.

Specific diagnosis.—Parafilaria: Male unknown.

Female: Body whitish, 40 to 50 millimeters in length by 0.40 millimeter in maximum diameter. Anterior extremity conical, adorned for the most part with prominent, transverse, cuticular ridges interrupted at irregular intervals, and at its tip with a limited number of small roundish tubercles or papillalike structures; the rest of the cuticle is distinctly striated, the striations being 3.5 to 4 microns apart.

Mouth small, with two inconspicuous lateral lips and surrounded by four small papillæ, of which one pair is lateral and the other median. Œsophagus weak, 0.23 to 0.25 millimeter long, communicating with mouth through a short narrow vestibule; intestine prominent, its posterior end including anus atrophied. Nerve ring at or very near middle of œsophageal length. Cervical papillæ inconspicuous, behind level of œsophagus, 0.28 to 0.30 millimeter from anterior end. Uteri convergent, meeting at level about 0.7 millimeter from anterior end to form the vagina. Vulva close to mouth, 54 to 56 microns from anterior end. Eggs very thin-shelled, embryonated, 40 to 52 by 27 to 33.2 microns in size; the inclosed larvæ are provided with a short taillike process and are 160 to 190 by 5 to 6 microns in size. Posterior end rounded, with a pair of minute papillæ, one on each side of subterminal anus.

Host.—Native cattle.

Location.—Skin nodules.

Locality.—Tanauan, Batangas, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 427.

Subfamily DIPLOTRIÆNINÆ Skrjabin, 1916

DIPLOTRIÆNA PYCNONOTI sp. nov. Plate 2, figs. 1 and 2.

The material available for description consists of one male and four female worms collected from *Pycnonotus goiavier*. The parasite appears to be very closely related to *Diplotriæna corrugata*, a Philippine species reported by Wehr (1930) from the body cavity of the bird *Ptilocichla basilanica*. It differs

from the latter, however, as well as from the other members of the genus *Diplotriæna* by the number and arrangement of its genital papillæ. In *D. corrugata* there are, according to Wehr, seven or eight papillæ near the tip of the posterior end of the body, while in the species under consideration there are definitely three pairs of ventral postanal papillæ.

Specific diagnosis.—Diplotriæna: Body cylindrical, tapering towards both extremities which, however, are rounded. Cuticle transversely striated in both sexes. Mouth a simple opening without lips, surrounded by two lateral and four submedian papillæ. Œsophagus very long, inconspicuously divided into a short anterior and a long posterior portion and carrying at its anterior extremity a pair of lateral chitinous structures or tridents. Teeth of tridents with transverse external corrugations, at least on distal two-thirds of their lengths; they often vary in length, the middle one of a set usually shorter. Nerve ring immediately in front of junction of anterior and posterior portions of œsophagus.

Male: Length 22 millimeters, maximum diameter 0.5 millimeter. Œsophagus 3.10 millimeters in total length, its anterior portion 0.35 millimeter long. Tridents 0.14 millimeter long. Nerve ring 0.25 millimeter from anterior end of body. Cloacal opening 0.11 millimeter from posterior end which is rounded and without lateral wings. Genital papillæ three pairs, all postanal, ventral, and provided with short peduncles. Spicules unequal: right spicule characteristically twisted at proximal and distal thirds of its length and measuring 0.55 millimeter in length by 45 microns in maximum diameter across its proximal end; left spicule slightly bent but not twisted, more pointed distally than its fellow, and measuring 0.78 millimeter in length by 60 microns in maximum diameter across its proximal end.

Female: Length 30 to 48 millimeters by 0.60 to 0.72 millimeter in maximum diameter. Œsophagus 3.4 to 4.0 millimeters in total length, its anterior portion 0.36 to 0.40 millimeter long. Tridents 0.17 to 0.19 millimeter long. Nerve ring 0.30 to 0.34 millimeter from anterior end. Vulva much behind junction of two œsophageal regions, 0.54 to 0.78 millimeter from anterior end. Eggs moderately thick-shelled, embryonated when ready to pass out of body, 45.7 to 47.8 by 31.2 to 33.2 microns in size.

Host.—Pycnonotus goiavier.

Location.—Subcutaneous tissue (below crop).

Locality.—Sipocot, Camarines Sur, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 411.

Subfamily SETARIINÆ Yorke and Maplestone, 1926

SERRATOSPICULUM THORACIS sp. nov. Plate 1, fig. 4; Plate 3, figs. 1 to 4.

According to the arrangement of their genital papillæ, the known members of the genus *Serratospiculum* Skrjabin, 1916, may be conveniently divided into two groups as follows: (*a*) those possessing at least five and (*b*) those with less than five preanal genital papillæ. To the first group belong *S. turkestanicum* Skrjabin 1916, *S. helicinum* (Molin, 1858) Walton, 1927, and *S. chungi* Hoeppli and Hsü, 1929; and to the second group *S. tendo* (Nitzch, 1857) and *S. guttatum* (Schneider, 1866), as described by Seurat (1915). The parasite in question, which is represented by two males and six females, is affiliated with the two latter species, differing from them in the greater size of its body and the length of its spicules.

Specific diagnosis.—*Serratospiculum:* Body elongate, bluntly conical anteriorly and more or less rounded posteriorly in both sexes. Caudal extremity of female straight, that of male curved ventrally and provided with short lateral wings. Mouth elongate dorsoventrally, with two insignificant lateral lips, each supported by a small epauletlike structure, subdivided into three areas each connected with a papilla. There are in addition two other papillæ on each side so that there are in all five pairs of mouth papillæ, the arrangement of which is shown in Plate 3, fig. 2. Œsophagus divided into a short, narrow anterior part and a long, broad posterior part which gradually tapers posteriorly. Nerve ring near middle of length of anterior portion of œsophagus. Cervical papillæ 0.28 to 0.30 and excretory pore 0.32 to 0.35 millimeter from anterior end.

Male: Length 150 to 160 millimeters, maximum diameter 0.46 to 0.58 millimeter. Œsophagus 11.3 to 14.5 millimeters in total length, its narrow anterior part about 0.4 millimeter long. Testis coiled a number of times around junction of anterior and posterior portions of œsophagus. Cloacal opening 0.12 to 0.15 millimeter from posterior end. There are ten pairs of genital papillæ and a median unpaired papilla immediately anterior to cloacal opening. The paired papillæ are arranged as follows: four pairs preanal, of which two pairs are lateral and pedunculated, and two pairs ventral and sessile; six pairs postanal, of which three pairs are lateral and pedunculated and three pairs

ventral and sessile. The two spicules are very unequal: left spicule 1.1 to 1.3 millimeters long, transversely striated and swollen behind middle of its length with a maximum diameter of 0.16 millimeter, and jointed between anterior and middle thirds of its length; right spicule 0.48 to 0.50 millimeter long, its posterior half winged and distinctly serrated.

Female: Length 185 to 315 millimeters, maximum diameter 0.64 to 0.80 millimeter. Œsophagus 14.4 to 15.0 millimeters in total length, its narrow anterior portion 0.4 to 0.5 millimeter long. Vulva with prominent lips, 1.00 to 1.12 millimeters from anterior end. A well-developed ovejector present. Eggs moderately thick-shelled, those found in ovejector embryonated and measuring 50 to 54 by 33.2 microns. Anus posterosubterminal, about 50 microns from posterior end.

Host.—Falco ernesti.

Location.—Embedded in walls of thoracic and abdominal cavities.

Locality.—Manila, P. I.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 404.

HAMATOSPICULUM OTOMELARUM sp. nov. Plate 4, figs. 1 to 4.

This species is represented in the collection by four males and two females. Following the lead of Sandground (1933), it is assigned to the genus *Hamatospiculum* Skrjabin, 1916, in spite of the presence of a cephalic cap (epauletlike structure), for in other morphological characters it agrees with the description of that genus. Compared with the other members of the genus it appears to be most similar to *H. quadriens* (Molin, 1858), as described by Boulenger (1928), but differs from it in the length of its spicules and the number of its caudal papillæ.

Specific diagnosis.—Hamatospiculum: Body cylindrical, tapering toward both extremities. Anterior end in both sexes rounded. Cuticle faintly striated transversely. Mouth a simple terminal opening bounded laterally by a pair of toothlike structures and five pairs of papillæ which in their arrangement have the appearance of an epauletlike structure (Plate 4, fig. 2). Œsophagus divided into a short anterior portion and a long posterior portion. Nerve ring across middle of anterior portion of œsophagus or immediately anterior to that level.

Male: 25 to 27 millimeters long by 0.50 to 0.54 millimeter in maximum diameter. Œsophagus 6.2 to 6.5 millimeters in total

length, its anterior portion 0.28 to 0.30 millimeter long. Posterior end rounded, with narrow alæ meeting posteriorly. Spicules very unequal; right spicule 0.33 to 0.37 millimeter in length by 29 microns in maximum width at proximal end; left spicule filiform, 2.95 to 3.15 millimeters by 33.3 microns in size. Genital papillæ six pairs, with very short peduncles and arranged as follows: four pairs preanal and ventral and two pairs postanal and lateral. Cloacal opening about 80 microns from posterior end.

Female: 82 to 90 millimeters long by 0.86 to 0.95 millimeter in maximum diameter. Œsophagus 9 to 11.2 millimeters in total length, its anterior portion 0.38 to 0.44 millimeter long. Vulva with prominent lips, 1.10 to 1.35 millimeters from anterior end. Anus about 80 microns from posterior end. Eggs moderately thick-shelled, embryonated when ready to be deposited, 52 to 56 by 33.2 to 35.6 microns in size.

Host.—Otomela lucionensis.

Location.—Under skin of head and neck and between trachea and œsophagus.

Locality.—Baao, Camarines Sur, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 428.

HAMATOSPICULUM LETICIÆ sp. nov. Plate 2, fig. 4.

This species is represented in the collection by two males and two females, one of which is badly damaged and therefore unfit for description. It is distinguished from *Hamatospiculum otomelarum* by its genital papillæ, of which there are five preanal pairs and three postanal pairs.

Specific diagnosis.—Hamatospiculum: Shape of body, structure of œsophagus, and arrangement of mouth papillæ as in *H. otomelarum.*

Male: 16 to 24.5 millimeters in length by 0.45 to 0.52 millimeter in maximum diameter. Total length of œsophagus 9.9 to 11.4 millimeters, its anterior portion 0.28 to 0.31 millimeter long. Posterior end rounded, with short narrow alæ meeting posteriorly. Spicules unequal: right spicule 0.265 to 0.300 millimeter in length by 25 microns in maximum width; left spicule 2.5 to 2.7 millimeters by 23 microns in size. Genital papillæ eight pairs, pedunculated and arranged as follows: five pairs preanal, and ventral; three pairs postanal, of which the second pair is ventral and the rest lateral. Cloacal opening about 50 microns from posterior end.

Female: 72 millimeters in length by 0.8 millimeter in maximum diameter. Total length of œsophagus 16.2 millimeters, its anterior portion 0.40 millimeter long. Vulva 1.0 millimeter from anterior end. Anus about 70 microns from posterior end. Eggs moderately thick-shelled, embryonated when ready to be oviposited, 47 to 54 by 31.2 to 33.3 microns in size.

Host.—*Halcyon chloris.*

Location.—Under skin of head and neck.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 429.

HAMATOSPICULUM DICRURI sp. nov. Plate 2, fig. 3.

This worm is represented in the collection by three males and five females. It differs from the preceding two species as well as from the other members of the genus *Hamatospiculum* in being smaller and in the number of its genital papillæ.

Specific diagnosis.—*Hamatospiculum:* Shape of body, structure of œsophagus, and arrangement of mouth papillæ as in the two preceding species.

Male: 22 to 25 millimeters in length by 0.5 to 0.7 millimeter in maximum diameter. Œsophagus 5.5 to 7.3 millimeters in total length, its anterior portion 0.29 to 0.32 millimeter long. Posterior end rounded with poorly developed alæ. Spicules unequal: right spicule 0.32 to 0.38 millimeter in length by 23 to 25 microns in maximum diameter; left spicule 2.4 to 2.9 millimeters by 25 to 29 microns in size. Genital papillæ nine pairs, pedunculated and arranged as follows: six pairs preanal and ventral; three pairs postanal, of which the first pair is ventral and the rest lateral. Cloacal opening 75 to 80 microns from posterior end.

Female: 38 to 54 millimeters in length by 0.60 to 0.85 millimeter in maximum diameter. Œsophagus 7.8 to 8.4 millimeters in total length, its thin anterior portion 0.32 millimeter long. Vulva with prominent lips, 0.92 to 1.00 millimeter from anterior end. Anus about 80 microns from posterior end. Eggs moderately thick-shelled, embryonated when ready to be deposited, 52 to 57.5 by 31.2 to 33.2 microns in size.

Host.—*Dicrurus balicassius.*

Location.—Under the skin of head.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 430.

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ILLUSTRATIONS

[Drawn by Mr. Alfredo C. Gonzales.]

PLATE 1

FIG. 1. *Parafilaria bovicola* sp. nov., anterior end of female, lateral view.
2. *Parafilaria bovicola* sp. nov., anterior end of female, ventral view.
3. *Parafilaria bovicola* sp. nov., posterior end of female, lateral view.
4. *Serratospiculum thoracis* sp. nov., anterior end of male, ventral view.

PLATE 2

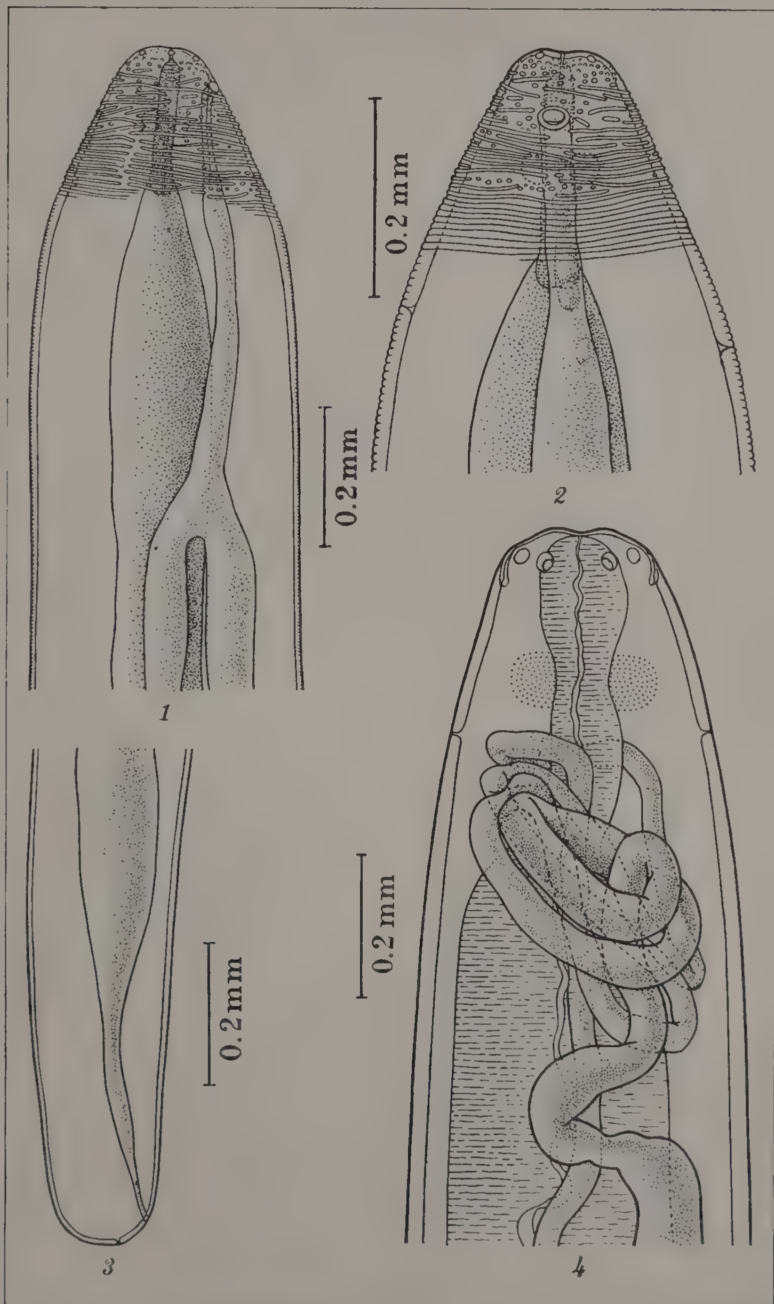
FIG. 1. *Diplotriæna pycnonoti* sp. nov., anterior end of female, lateral view.
2. *Diplotriæna pycnonoti* sp. nov., posterior end of male, ventral view.
3. *Hamatospiculum dicruri* sp. nov., posterior end of male, ventral view.
4. *Hamatospiculum leticiæ* sp. nov., posterior end of male, ventral view.

PLATE 3. SERRATOSPICULUM THORACIS SP. NOV.

FIG. 1. Anterior end of female, lateral view.
2. Mouth and papillæ, anterior view.
3. Posterior end of female, lateral view.
4. Posterior end of male, ventral view.

PLATE 4. HAMATOSPICULUM OTOMELARUM SP. NOV.

FIG. 1. Anterior end of female, lateral view.
2. Mouth and papillæ, anterior view.
3. Posterior end of female, lateral view.
4. Posterior end of male, ventral view.



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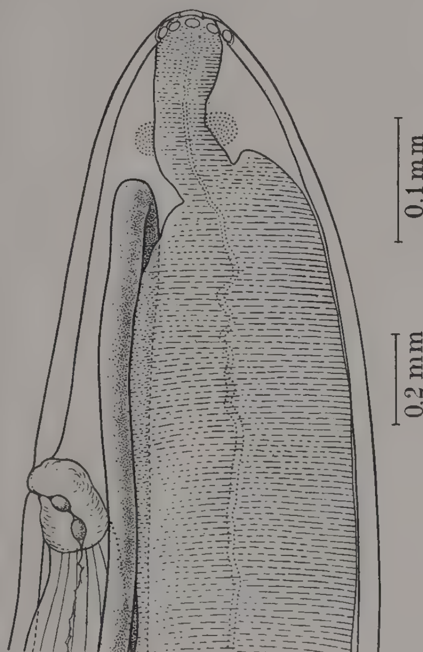

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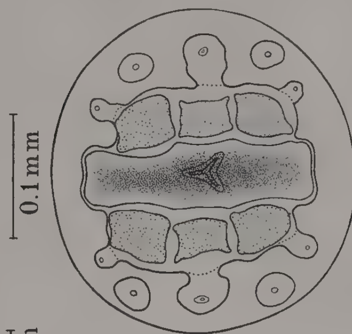

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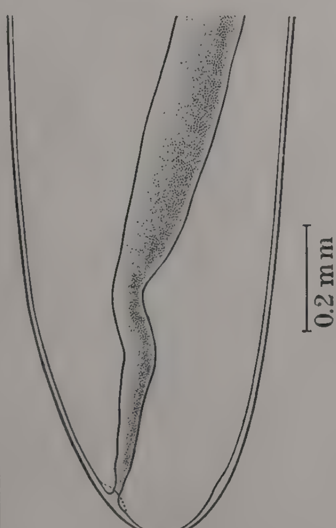

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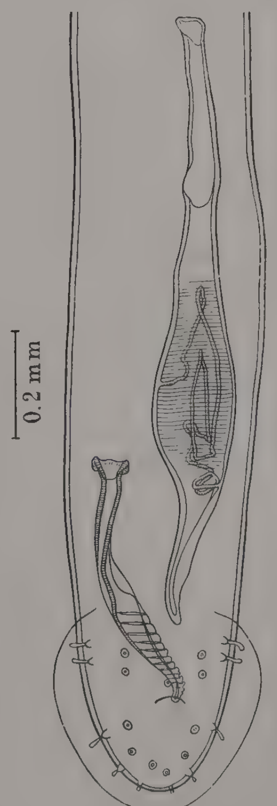

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PLATE 3.

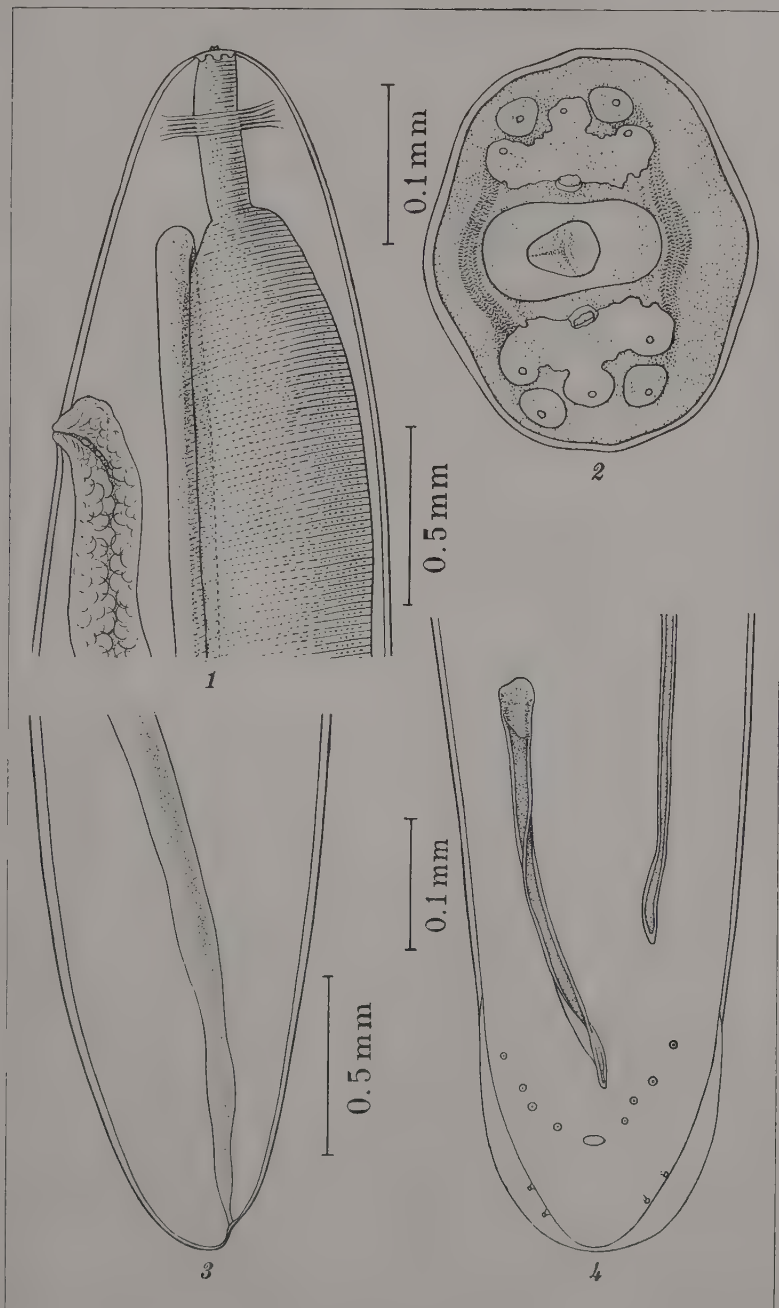

PLATE 4.

HÆMORRHAGIC FILARIASIS IN CATTLE CAUSED BY A NEW SPECIES OF PARAFILARIA [1]

By ZACARIAS DE JESUS

Of the Veterinary Research Division, Bureau of Animal Industry, Manila

ONE PLATE AND ONE TEXT FIGURE

INTRODUCTION

An unusual case of parasitism in cattle characterized by profuse local hæmorrhages from slightly raised nodules was discovered by the writer July 2, 1932, in Tanauan, Batangas, Philippine Islands.

The subject was a native bull (*Bos taurus*), ashey red in color, eight years old, and belonging to Miss Victorina Macaisa and her sisters. The animal has been raised and is used for plowing in Barrio Kale of the municipality of Tanauan. The owners as well as the tenant using this animal observed this condition for the first time in 1931.

A survey of the barrio of Kale April 28, 1933, revealed that four other cattle of both sexes, from two to five years old, were affected. A carabao, male, six years old, show the same symptoms, but no worm was recovered from two lesions. None of the horses raised in the same barrio and coming in contact with the infested cattle showed any symptom of this disease.

Railliet and Moussu (1922) report the occurrence of hæmorrhagic filariasis in the donkey. They point out that the parasite is lodged in the intermuscular, interfascicular, and subcutaneous connective tissue. These writers cite the reports of Sibal of its occurrence in horses of Tartaric origin, of Spinola and Leblanc in Russian horses, and of Bernard and Liautard in mules in Algeria. Drouilly, Trasbot, Mégnin, von Ratz, and others, according to Neumann (1910) and Hutyra and Marek (1926), observe hæmorrhagic filariasis in horses of Hungarian, Russian, and Tartaric origin.

Drouilly (1877) (Cited by Railliet and Moussu, 1892) reports the cause of hæmorrhagic filariasis in equines as *Filaria papillosa* [= *Parafilaria multipapillosa* (Condamine and Drouilly,

[1] Bureau of Animal Industry Technical Bulletin 6. Received for publication July 21, 1934.

1878)] (=*Filaria haemorrhagica* Railliet, 1885). Yorke and Maplestone (1926) and Baylis (1929) record only one species of *Parafilaria* from the horse tribe. According to Baylis (1929), *Parafilaria multipapillosa* is a parasite of the horse, donkey, and mule, and occurs chiefly in Oriental countries or in animals of Eastern origin. This writer states that it inhabits the subcutaneous and intermuscular connective tissue, and is the cause of a troublesome affection variously known as hæmorrhagic filariasis or parasitic dermatorrhagia.

There is no report, however, on the occurrence of this disease in cattle nor the collection of a species of *Parafilaria* from bovines. Hence, the present study here reported, which covered a period of two years, may be the first record of hæmorrhagic filariasis in cattle caused by another species of *Parafilaria.*

ETIOLOGY

The causal organism is a filaria belonging to the genus *Parafilaria* Yorke and Maplestone, 1926. The female has a whitish body measuring from 40 to 50 millimeters in length by 0.40 millimeter in maximum diameter. The eggs, which are very thin-shelled and are already embryonated when laid, are 40 to 52 by 27 to 33.2 microns in size. Several specimens of this parasite were submitted to Dr. Marcos A. Tubangui of the Philippine Bureau of Science who describes them in a preceeding paper in this issue of the Philippine Journal of Science as *Parafilaria bovicola.*

The females of this *Parafilaria* were found lodged in the nodules (fig. 1, *f*). No male specimen was recovered from the lesions. The locations of the males as well as the other locations of the females have not been determined for there has been no opportunity to post an infested animal. For this reason the complete pathology of the disease has also not yet been determined.

The life history and transmission of this parasite is not yet known. The writer has an infested bull under observation in an attempt to determine the mode of transmission as well as the life history of the parasite.

SYMPTOMS

The infested animals at first showed slightly raised nodules scattered on the different parts of the body and neck. The nodules were irregular, and were from 5 to 7 millimeters thick and from 15 to 25 millimeters in diameter at the base. As a

rule these nodules were not painful on palpation. They were tough and the skin covering them was thickened. But the involved skin at this stage of the disease did not show any sign of inflammation. The first symptoms generally appeared about the beginning of December.

Two to three weeks later some nodules began to bleed profusely and became enlarged and slightly raised, attaining a maximum diameter of 40 millimeters at the base and a maximum thickness of 10 millimeters (Plate 1, figs. 1 and 2 marked *b*). On palpation the bleeding nodules were painful and were as tough as the nonbleeding ones (*n*). At the highest point of a bleeding nodule there was a fistulous tract or opening extending through the skin, measuring about 1 millimeter in diameter, from which the blood oozed out (fig. 1, *e*). In one case the blood was actually seen dripping slowly in a tiny stream from a nodule on the back down across the side to the belly. Incision through the skin along the fistulous tract showed that the tissues immediately around the tract were highly inflamed with a thin layer of necrotic tissues lining the tract.

The hæmorrhage was more profuse in animals that were used for plowing or pulling carts and in those that grazed in the open on hot days. The bleeding was recurrent. In exceptional cases, however, the hæmorrhage took place during the hotter part of the day and subsided at night, and then recurred every day for three to five days. If not attended to, the bleeding stopped by itself, the fistulous tract becoming plugged with some coagulated blood. The hæmorrhage per se did not seem to affect the patient. But sometimes as many as seven nodules were bleeding profusely at the same time in which case the infested animal showed general debility. It had a pale mucous membrane indicating anemia, lost in weight, and its pulling power was much reduced.

One infested animal, 8 years old, male, and used for plowing, was examined at long intervals for the occurrence and the distribution of the nodules. The symptoms were seasonal in their occurrence and variable in their duration as shown in Table 1. The distribution of the nodules was also variable. They were generally manifested by the infested animals during the period from the latter part of December to the middle part of July. Then all the nodules disappeared completely. At other times, the disease, in all its stages, persisted even up to the middle of September.

TABLE 1.—*Showing the occurrence and distribution of the nodules.*

Date.	Non-bleeding nodules.	Bleeding nodules.	Location.
July 2, 1932	4	7	Neck, withers, shoulders, and back.
July 16, 1932	7	3	Neck, withers, shoulders, back, and thigh.
April 28, 1933	3	1	Neck and shoulders.
May 15, 1933	4	5	Neck, shoulders, and back.
September 7, 1933	3	0	Neck and shoulders.
October 9, 1933	0	0	
November 13, 1933	0	0	
December 29, 1933	2	1	Neck and shoulders.
February 27, 1934	3	2	Neck, shoulders, and back.

DIAGNOSIS

Hæmorrhagic filariasis in cattle was diagnosed by the presence of the characteristic symptoms and the recovery of the *Parafilaria* from the nodules. Incipient cases were difficult to diagnose due to the absence of profuse local hæmorrhages which were pathognomonic of the disease. It had been observed that the worms were not present in nonbleeding nodules. In advanced cases the characteristic local hæmorrhages from the

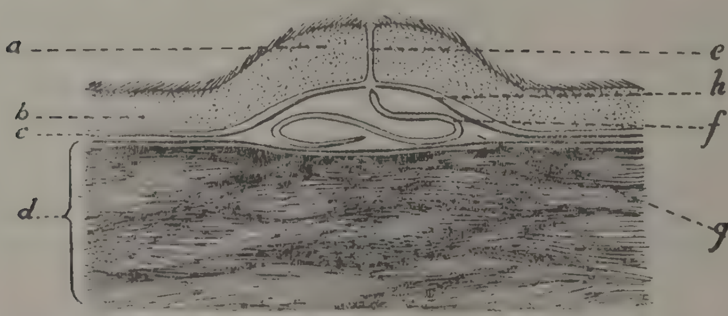

FIG. 1. A schematic drawing showing the cross section of a nodule with a *Parafilaria* in situ.

apices of the nodules were very prominent and the parasite could be recovered from the bleeding nodule.

This *Parafilaria* could be removed intra vitam from the nodules only by surgical means. For the sake of clarity the worm in situ is shown in a schematic drawing (fig. 1). By making an incision, 4 to 5 centimeters long, through the skin, a small fascicular fold (fig. 1, *h*) 2.5 centimeters in diameter, can be seen just beneath the skin. After cutting open the wall of the

TABLE 2.—*Showing the results of the examinations of the nodules for Parafilaria.*

Date.	Nonbleeding.		Bleeding.		Worms in each nodule.
	Number.	Positive.	Number.	Positive.	
July 2, 1932	1	0	2	1	One female.
July 16, 1932	0	0	2	2	Do.
April 28, 1933	3	0	1	0	None.
May 15, 1933	0	0	3	2	One female.
September 7, 1933	2	0	0	0	None.
December 29, 1933	1	0	2	1	One female.
February 27, 1934	0	0	1	1	Do.

sac or cyst, the worm (*f*) comes out with a little amount of seropurulent fluid. Only female worms were collected by this method. Just where the younger females as well as the males are lodged in the body of the host has not yet been determined.

The bleeding and nonbleeding nodules of some infested cattle were examined surgically for the presence of *Parafilaria*. The results are shown in Table 2. Deep skin scrapings from each of three bleeding and three nonbleeding nodules as well as the blood from the ear vein of each of three cattle were examined twice for *Microfilaria*. All the samples were negative. Several microscopic examinations of the blood oozing out from ten nodules were also negative. It is highly probable, however, that either the embryonated eggs or the larvæ may be found coming out of the nodules with the blood at a certain stage of the hæmorrhage. Hence, further investigation is being conducted to determine this point.

In the pre-bleeding stage of the disease the nodules may be confused with those of urticaria and insect bites. In the advanced stage the bleeding nodules may be mistaken for the lesions in skin myiasis. In myiasis, however, there is hardly any swelling of the affected parts, and on palpation the skin sinks and a sanguinous pus, which fills the cavity under the skin, oozes out. The opening is much larger and irregular in myiasis, and in most cases the maggots can be recovered from the cavities.

SUMMARY

1. Hæmorrhagic filariasis in cattle, which occurs in Tanauan, Batangas, Philippine Islands, and is characterized by profuse local hæmorrhages from slightly raised nodules, is hereby reported possibly for the first time.

2. This filariasis is caused by a new species of filaria (*Parafilaria bovicola*).

3. Only mature females were found in the bleeding nodules, and no specimens were found in the nonbleeding ones.

4. The occurrence of the disease is seasonal and its duration variable.

5. While the disease is benign, heavily infested animals, on account of general debility as a sequel, are predisposed to more dangerous microbian diseases.

6. This species of *Parafilaria* is apparently not transmissible to horses.

7. While no parasites were found in the bleeding nodules of a carabao presenting symptoms very similar to those manifested by infested cattle, there is reason to suppose that carabaos are susceptible to this parasitic disease.

ACKNOWLEDGMENT

The writer is indebted to the College of Veterinary Science for the facilities afforded him in conducting this investigation while still in Los Baños. Thanks are due Dr. Teodulo Topacio, chief of the Veterinary Research Division, for his valuable suggestions, and Miss Victorina Macaisa and her sisters for kindly allowing the writer to conduct this investigation on their farm.

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ILLUSTRATIONS

PLATE 1

FIG. 1. A bull suffering from hæmorrhagic filariasis, showing nodules.

2. A close-up of a portion of the body of the same animal showing bleeding (*b*) and nonbleeding (*n*) nodules.

(Photographed by the author. Enlarged by the Division of Publications, Department of Agriculture and Commerce.)

TEXT FIGURE 1. A schematic drawing showing the cross section of a nodule with a *Parafilaria* in situ.

a. Indurated skin over the nodule.
b. Normal skin.
c. Fascia.
d. Muscles.
e. Fistulous tract.
f. Parafilaria.
g. Fascicular sac or cyst.
h. Fold of fascia.

PLATE 1.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXII [1]

By CHARLES P. ALEXANDER
Of Amherst, Massachusetts

THREE PLATES

The crane flies discussed herewith are chiefly from Celebes Island, where they were collected by my friend and colleague Mr. Charles F. Clagg. A further considerable series of species are from Formosa where they were secured by Messrs. Esaki, Gressitt, and Issiki. One further species is from Korea where it was taken by Professor Masaki. The Esaki material has been returned to Professor Esaki for incorporation in the collection of the zoölogical laboratory, Kiushiu Imperial University; all other species are preserved in my own extensive series of these flies through the friendly interest of the various collectors.

TIPULINÆ

TIPULA (LUNATIPULA) MULTIBARBATA sp. nov. Plate 1, fig. 1; Plate 2, figs. 25, 26.

Belongs to the *marmoratipennis* group; antennæ weakly bicolorous, the bases of the flagellar segments narrowly pale; præscutal stripes four in number, gray, narrowly bordered by brown; femora yellow, the tips narrowly brownish black; wings creamy white, heavily marmorate with pale brown and darker brown clouds; male hypopygium with conspicuous brushes of long yellow setæ on the tergite and on the eighth sternite, the latter sclerite extensive but not extended far caudad into a boat-shaped structure, as is the case in certain other species of the group.

Male.—Length, about 15 millimeters; wing, 21.

Frontal prolongation of head brownish, the long strong nasus chiefly yellow; palpi yellow, the outer segments somewhat darker. Antennæ of moderate length, if bent backward extending to some distance beyond wing root; scape and pedicel yellow; flagellar segments dark brown, the extreme proximal ends of the basal enlargements yellow, to produce a weak bicolorous ap-

[1] Contribution from the entomological laboratory, Massachusetts State College.

pearance; longest verticils subequal to the segments; last flagellar segment approximately one-half as long as the penultimate. Head light ashy gray, the center of vertex extensively cinnamon-brown, with a further dark brown, capillary, median vitta.

Mesonotal præscutum light gray, with four distinctly separated, darker gray stripes that are narrowly bordered by brown; scutal lobes gray, with darker gray central areas; posterior sclerites of notum gray, with a capillary brown median vitta. Pleura gray, the dorsopleural region rather light brown. Halteres yellow, the base of knob brown, the apex yellowish. Legs with the coxæ yellowish, sparsely pruinose; trochanters yellow; femora yellow, the tips narrowly brownish black, somewhat lighter on the flexor surface; tibiæ brownish yellow, the tips narrowly and rather weakly infuscated; tarsi passing into brownish black. Wings (Plate 1, fig. 1) with the ground color whitish cream, variegated with pale brown and darker brown, the general appearance being rather heavily marmorate; cell Sc uniform yellow, contrasting with the whitish cell C; post-arcular darkening in bases of cells R and M restricted; stigma brown, its central portion more yellow; the darkened clouds leave a narrow oblique band of the ground color extending from behind origin of Rs to the wing margin in cell 1st A; veins brown. Macrotrichia of veins relatively small and weak, on R_3 restricted to two or three near outer end of vein; squama with about sixteen to eighteen strong black setæ. Venation: Free tip of Sc_2 far before R_{1+2}, so cell Sc_2 at costa is unusually extensive; Rs elongate, exceeding twice m-cu; vein R_3 rather strongly arcuated, slightly narrowing cell R_3 at near midlength; cell 1st M_2 relatively long, m being much longer than the basal section of M_{1+2}; m-cu at fork of M_{3+4}.

Abdominal tergites one to five light grayish yellow, each with an interrupted brown median dash, the lateral borders of tergites one to two narrowly dark brown; lateral borders of tergites narrowly silvery gray, increasing in area on the outer segments; sixth and succeeding tergites passing into brownish black; sternites with basal five segments yellow, the outer ones darker. Male hypopygium (Plate 2, fig. 25) with the ninth tergite, *9t*, fused with the sternite, *9s*, on posterior half; basistyle and the small sternite entirely fused. Ninth tergite (Plate 2, fig. 25, *9t*) narrow, constricted by pale membrane on cephalic portion; caudal margin with a median and two lateral lobes that are densely set with short blackened setæ; behind or ce-

phalad of these three cushions, on either side of midline, a transverse group of long conspicuous erect yellow setæ; viewed laterally, the median black cushion is seen to lie farther cephalad than the more-projecting lateral pair. Outer dististyle broad on basal half, the outer half more narrowed, the inner face set with small black spines, of which the outer two or three are larger and more conspicuous. Inner dististyle, *id*, about as shown, the outer angle a powerful black spine; viewed separately and in a flattened condition, the style appears conspicuously bilobed on inner margin, with a deep U-shaped emargination separating the lobes. Eighth sternite (Plate 2, fig. 26, 8*s*) very extensive, sheathing, the lateral edges extending high up over the sides of the ninth sternite, the outer lateral angles produced into pale bulbous lobes that are set with abundant long pale setæ; median area of sternite truncate, with a transverse row of long yellow setæ.

Habitat.—Korea.

Holotype, male, Shorei, July 9, 1923 (*J. Masaki*).

The *marmoratipennis* group includes, besides the typical form and the present fly, three Japanese species, *holoteles* Alexander, *naviculifer* Alexander, and *shogun* Alexander, that are among the most beautiful and conspicuous of all Japanese species of *Tipula*. The group is best distinguished by the short, fleshy valves of the ovipositor, and by certain venational details, as the unusually long Rs and the more or less arcuated vein R_3, which tends to narrow cell R_3. I have been privileged to study both the type and paratype of *marmoratipennis* Brunetti (holotype, female, Darjiling, altitude 7,000 feet, May, 1910—not "April" as stated by Brunetti—paratype, female, Darjiling, August 7, 1909), through the friendly interest of the authorities of the Indian Museum.

The present fly is very different from the other Japanese species listed above. The male hypopygium is quite distinct, notably the eighth sternite, which, while very extensive and sheathing, yet is not at all narrowed into a boat-shaped median lobe as in the other species (male sex not yet known in *holoteles*).

DOLICHOPEZA (NESOPEZA) TOALA sp. nov. Plate 1, fig. 2; Plate 2, fig. 27.

Belongs to the *costalis* group; mesonotal præscutum dark cinnamon-brown; pleura almost uniformly dark brown, only the ventral pteropleurite restrictedly paler; legs with the femora obscure yellow, the tips weakly darkened; tibiæ dirty brown; tarsi snowy white; wings with the ground color rather strongly

infumed; cell M_1 subequal to or shorter than its petiole; male hypopygium with the median area of tergite produced into a low triangular point; eighth sternite with the median area slightly produced and provided with pale yellow setæ.

Male.—Length, about 8.5 to 9 millimeters; wing, 10 to 10.5.

Female.—Length, about 11 millimeters; wing, 11.

Rostrum and palpi dark brown. Antennæ with the scape and pedicel light brown; first segment of flagellum obscure yellow, the outer segments dark brown; flagellar segments cylindrical, with short inconspicuous verticils. Head with the front and anterior vertex cinnamon-brown, the posterior vertex and occiput darker brown.

Mesonotal præscutum and scutum dark cinnamon-brown; scutellum and mediotergite a little darker brown. Pleura dark brown, only the ventral pteropleurite restrictedly paler. Halteres pale, the knobs dark brown. Legs with the fore and middle coxæ dark brown, the posterior coxæ more testaceous; trochanters yellow; femora obscure yellow, the tips weakly darkened; tibiæ dirty brown, the extreme base more whitened; tarsi snowy white (fore and hind legs broken). Wings (Plate 1, fig. 2) with the ground color rather strongly infumed; the usual dark costal pattern of the *costalis* group is present, the areas not margined by paler; cell R_3 with brown clouds on outer portion, including a band at two-thirds the length; cell Cu darkened; veins dark brown. Venation: Rs elongate and spurred, as in group; medial forks short, cell M_1 subequal to or shorter than its petiole; cell 2d A relatively wide.

Abdomen with basal segments chiefly obscure yellow, beyond the second chiefly dark brown, especially medially and at outer ends. Male hypopygium (Plate 2, fig. 27) with the median area of tergite, 9*t*, produced into a low triangular point. Eighth sternite, 8*s*, with the median area slightly produced and provided with pale yellow setæ, some of which are decussate at midline.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*). Allotopotype, female. Paratopotypes, 2 males.

The specific name is that of an aboriginal tribe of Celebes. The only allied species is *Dolichopeza* (*Nesopeza*) *borneensis* (Edwards), of North Borneo, which differs in the coloration of the wings and the uniformly pale thoracic pleura. This latter

species has Rs with a longer basal spur and lying closer to R_1 than is the case in the present fly.

DOLICHOPEZA (NESOPEZA) PROFUNDEMARGINATA sp. nov. Plate 1, fig. 3; Plate 2, fig. 28.

Belongs to the *costalis* group; most nearly allied to *geniculata;* basal segments of flagellum pale; pleura brown, the dorsopleural region and pteropleurite whitish; male hypopygium with median area of tergite unequally trilobed, separated from the slender lateral arms by narrow incisions; eighth sternite long and sheathing, profoundly emarginate medially, each lateral lobe obtusely rounded.

Male.—Length, about 8 millimeters; wing, 9.2.

Female.—Length, about 10 millimeters; wing, 9.

Rostrum dark brown; palpi brown, especially the outer segment. Antennæ with scape dark brown, pedicel a trifle paler; flagellum with basal segments white, the outer ones passing into pale brown; flagellar segments cylindrical, with verticils that are shorter than the segments. Head pale brown.

Mesonotum brown, the præscutal stripes scarcely demarked. Pleura brown, the dorsopleural region and pteropleurite whitish. Halteres white, the knobs dark brown. Legs with the coxæ dark brown, the posterior pair paler on basal portions; trochanters pale yellow; femora pale yellow, the tips broadly and conspicuously black, preceded by a narrow, more whitish ring; tibiæ dirty white, the tips narrowly blackened, preceded by a clearer ring; tarsi snowy white. Wings (Plate 1, fig. 3) with the ground color grayish, with the usual dark brown pattern of the group, the costal areas narrowly bordered behind by whitish; isolated white spots in outer ends of cells R_3 and R_5; small white spots at h and arculus; veins chiefly pale brown, the cord and elements lying in the dark markings brown. Venation: Basal spur of Rs elongate; forks of medial field short.

Abdominal tergites dark brown, the lateral portions of the second tergite restrictedly pale; succeeding tergites variegated beyond base with obscure yellow. Male hypopygium with the ninth tergite (Plate 2, fig. 28, 9*t*) having the median area protuberant, unequally trilobed, separated from the lateral portions by a notch; lateral arms relatively slender, with several small wartlike points. Eighth sternite, 8*s*, large and sheathing, profoundly emarginate medially, forming two short cylindrical lobes with blunt tips; at base of notch, on either side, with a small lobule; median region of sternite cephalad of base of emargination with pale membrane almost to border of sclerite.

Habitat.—Formosa (north).

Holotype, male, Urai, altitude about 1,500 feet, April 1, 1932 (*Gressitt*). Allotype, female, Giran, November 20, 1928 (*Issiki*).

Dolichopeza (*Nesopeza*) *profundemarginata* is very similar to *D.* (*N.*) *geniculata* Alexander (Japan) in all colorational features, differing notably in the structure of the male hypopygium, especially the long, sheathing sternite that is deeply emarginate.

DOLICHOPEZA (NESOPEZA) TORAJA sp. nov. Plate 1, fig. 4; Plate 2, fig. 29.

Belongs to the *gracilis* group; wings tinged with brown, the usual darkened pattern of the group very poorly defined and not extending distad beyond the stigma; male hypopygium with median region of tergite only slightly convex; eighth sternite unarmed.

Male.—Length, about 8 millimeters; wing, 8.8.

Rostrum and palpi dark brown. Antennæ with scape dark brown, the succeeding segments paler brown; flagellar segments long-cylindrical, clothed with a short dense white pubescence and with short inconspicuous verticils. Head dark brown.

Mesonotal præscutum brown, with three brownish black stripes, the median one elongate, the laterals abbreviated; scutal lobes variegated with dark brown; scutellum brownish black; mediotergite brown. Pleura distorted in the unique type, apparently almost uniform brown. Halteres elongate, black, the base of stem restrictedly pale. Legs with the coxæ brownish; trochanters paler; remainder of legs broken. Wings (Plate 1, fig. 4) with the ground color weakly tinged with brown; the usual dark costal pattern of the group is here only faintly differentiated from the ground color, being indicated by a darkening at base, the costal region and the stigma, with further very restricted clouds at origin of Rs, anterior cord, and end of vein Cu_1; no darkening beyond stigma; veins dark brown. Venation: Rs elongate, angulated and long-spurred near origin; medial forks relatively deep.

Abdominal tergites weakly bicolorous, the basal half or more brownish yellow; posterior ring dark brown or brownish black. Male hypopygium (Plate 2, fig. 29) with the median region of tergite, 9*t*, almost transverse or only feebly elevated, narrowly blackened; lateral lobes of tergite obtuse. Inner dististyle, *id*, with the apical beak slender. Eighth sternite, 8*s*, with the caudal margin very gently convex, without special armature of lobes or setæ.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*).

The specific name is that of an aboriginal tribe inhabiting central, southeastern, and eastern Celebes. *Dolichopeza* (*Nesopeza*) *toraja* is very distinct from all other members of the *gracilis* group in the slightly infumed wings and scarcely differentiated dark costal pattern.

LIMONIINÆ

LIMONIINI

LIMONIA (LIBNOTES) FALSA sp. nov. Plate 1, fig. 5; Plate 2, fig. 30.

Mesonotal præscutum shiny reddish, the posterior sclerites of mesonotum and the pleura variegated with dark brown or brownish black; antennæ black throughout, the flagellar segments with long verticils; halteres yellow, knobs brownish black; wings whitish subhyaline, prearcular region yellow; costal border of wings dark brown; free tip of Sc_2 lying far before level of R_2; m-cu opposite midlength of cell 1st M_2; anal veins convergent; abdominal tergites brownish black medially, pale laterally; male hypopygium with the rostral prolongation long and slender, with two small spines at base.

Male.—Length, about 7 millimeters; wing, 8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments long-oval, with elongate verticils that considerably exceed the segments. Head dark gray, the front and very narrow anterior vertex silvery.

Pronotum dark brown above, more yellowish on sides. Mesonotal præscutum shiny red, unmarked; scutum dark brown, the centers of the lobes more castaneous; scutellum testaceous-brown; mediotergite dark brown. Pleura with the propleura and ventral sternopleurite more yellowish; dorsal sternopleurite, anepisternum, and posterior pleural sclerites darker brown. Halteres yellow, the knobs brownish black. Legs with the coxæ and trochanters yellow; femora yellow basally, at near midlength becoming darker, at tips passing into brownish black; tibiæ brownish yellow, the tips narrowly darker; tarsi brownish yellow, the outer segments darker. Wings (Plate 1, fig. 5) whitish subhyaline; prearcular region light yellow; costal border, including cells C and Sc, dark brown, the color continued outward to wing tip; stigma very small, still darker brown; brown seams along vein Cu_1, on m-cu and in axillary region; veins dark brown,

luteous in the prearcular field. Macrotrichia of veins long and conspicuous. Venation: Sc_2 ending about opposite midlength of cell 1st M_2, Sc_2 longer than Sc_1; Rs elongate; free tip of Sc_2 far before level of R_2; R_1 with numerous trichia; R_{1+2} jutting beyond R_1 as a slight spur or thickening; outer radial veins moderately decurved at tips; m-cu at midlength of cell 1st M_2; vein 2d A converging strongly toward 1st A.

Abdominal tergites yellow, brownish black medially, forming a continuous median stripe that is a little expanded at the posterior borders of the segments; sternites yellow, segments eight and nine brownish black, the styli pale. Male hypopygium (Plate 2, fig. 30) with the tergite, *9t*, broadly transverse, the caudal border convex. Ventral dististyle, *vd*, smaller in area than the basistyle; rostral prolongation long and slender, with two rostral spines close to its base; a pale lobe on face of style opposite base of prolongation (not shown in figure). Mesal-apical lobe of gonapophysis slender. Ædeagus, *a*, very broad.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*).

Despite its small size and the unusual pattern of the wings, the present fly belongs to the typical section of the subgenus, having convergent anal veins and a hypopygium of the general structure of this group of species. In Edwards's key to the species of *Libnotes* [2] the fly runs to couplet 28, disagreeing with all species beyond by the wing pattern and venation of the radial field, especially the position of the free tip of Sc_2 some distance proximad of R_2.

LIMONIA (LIBNOTES) COMISSABUNDA sp. nov. Plate 1, fig. 6.

General coloration of mesonotum buffy, the præscutum vaguely lined with darker; antennæ black; femora yellow, with a brown subterminal ring; wings whitish subhyaline, with a restricted brown pattern, including seams along cord and outer end of cell 1st M_2; vein R_{2+3} strongly arcuated at proximal end; cell 1st M_2 elongate, widened at outer end, m-cu at near one-third its length; m gently arcuated, about twice the basal section of M_3; anal veins convergent at bases; ovipositor with cerci bidentate at tips.

Female.—Length, about 10 millimeters; wing, 12.

Rostrum and palpi brownish black. Antennæ brownish black; flagellar segments oval, the longest verticils about twice the seg-

[2] Journ. Fed. Malay St. Mus. 14 (1928) 74–80.

ments. Front and anterior vertex light golden yellow; posterior vertex grayish brown, the central portion more fulvous, with a further capillary dark line.

Pronotum buffy on sides and as a mid-dorsal vitta, the remainder of dorsum dark brown. Mesonotum buffy, vaguely lined with darker, including a pair of intermediate brown stripes; posterior sclerites of notum sparsely pruinose, the centers of the scutal lobes darker. Pleura pale, the propleura and ventral anepisternum weakly darkened. Halteres elongate, yellow, the knobs dark brown basally, the apices a little brightened. Legs with the fore coxæ a trifle darker than the others, middle and posterior coxæ yellow; trochanters yellow; femora yellow with a brown subterminal ring at about its own width before the tip; tibiæ light brown, the tips narrowly darkened, the outer tarsal segments darkened. Wings (Plate 1, fig. 6) whitish subhyaline, the prearcular and costal regions more yellow; a restricted brown pattern, appearing as seams to certain of the veins, including the cord and outer end of cell 1st M_2; basal half of R_{2+3} and adjoining portions of outer end of vein Sc; narrow stigmal area; outer third of 2d A; less distinct clouds at arculus and in axillary region; veins yellow, dark brown in the clouded areas. Venation: Sc long, Sc_1 ending beyond m-cu, Sc_2 at its tip; Rs gently arcuated; R_{2+3} strongly arcuated at proximal end, constricting cell R_1 at near one-third the length; R_3 decurved at outer end; free tip of Sc_2 and R_2 in approximate transverse alignment; cell 1st M_2 elongate, widened at outer end; m gently arcuated, about twice the basal section of M_3; m-cu at just before one-third the length of cell 1st M_2; anal veins convergent at bases.

Abdominal tergites variegated with dark brown and obscure yellow, the ground color dark, the caudal borders more yellow; sternites with the pattern similar but less contrasted. Ovipositor with the cerci bidentate at tips.

Habitat.—Formosa (north).

Holotype, female, Taiheizan, May 6, 1932 (*Gressit*).

In Edwards's key to the species of *Libnotes* [3] the present fly runs to *Limonia* (*Libnotes*) *nohirai* (Alexander), which differs notably in the broadly blackened tips of the femora and in the details of venation. In its general appearance the species also suggests species such as *L.* (*L.*) *amatrix* (Alexander), but differs

[3] Loc. cit.

conspicuously in the pattern of the legs and wings, and in the venation.

LIMONIA (LIMONIA) ALOPECURA sp. nov. Plate 1, fig. 7; Plate 2, fig. 31.

Belongs to the *pendleburyi* group; coloration almost uniformly pale testaceous-brown to reddish brown; antennæ relatively long; wings whitish subhyaline, the stigma conspicuous, dark brown; cell 1st M_2 large, exceeding the veins beyond it; male hypopygium unusually complex in structure, the basistyle bearing three distinct lobes and outgrowths on mesal face.

Male.—Length, about 5 millimeters; wing, 6.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi brown. Antennæ relatively long; scape and pedicel dark brown, flagellum paler, testaceous-brown; flagellum moniliform, the segments strongly constricted at outer ends into short pedicels; terminal segment longer than the penultimate, strongly pointed at outer end; flagellar segments with abundant pale setæ. Head dark gray.

Mesonotum and pleura almost uniformly pale testaceous-brown to reddish brown. Halteres pale, the knobs weakly darkened. Legs with the coxæ and trochanters testaceous-yellow; femora whitish, the tips narrowly darkened; tibiæ and basitarsi dirty white, the tips narrowly darkened; outer tarsal segments darkened. Wings (Plate 1, fig. 7) whitish subhyaline, the oval stigma conspicuous, dark brown; veins yellow, beyond the cord more brownish yellow. Venation: Sc_1 ending shortly beyond midlength of Rs, Sc_2 at its tip; free tip of Sc_2 and R_2 in approximate transverse alignment, or the latter a little more basad; cell 1st M_2 large, exceeding the veins beyond it; m-cu shortly beyond fork of M, subequal to the distal section of Cu_1.

Abdominal tergites brown, the sternites yellow. Male hypopygium (Plate 2, fig. 31) with the caudal border of the long tergite, *9t*, convexly rounded. Basistyle, *b*, with the mesal armature consisting of three complex lobes; namely, first, a short flattened blade that terminates in a comblike series of acute spines; second, a dusky blade, the base narrow, the apex expanded, obliquely truncate, with long coarse setæ; third, a slender-based spatulate lobe, the dilated head with recurved delicate setæ. Dististyle, *d*, complicated by lobes and outgrowths, the most conspicuous element being a broadly flattened spatula that is densely clothed with long setæ. Gonapophyses, *g*, with the outer margin corrugated as in group.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 4,500 to 6,000 feet, May 25, 1931 (*Clagg.*) Allotype, female, altitude 5,800 feet, May 24, 1931 (*Clagg*).

Limonia (*Limonia*) *alopecura* resembles other species of the *pendleburyi* group in its general appearance but is very different in the unusually complicated male hypopygium, especially the basistyle.

LIMONIA (LIMONIA) INSCITA sp. nov. Plate 1, fig. 8; Plate 2, fig. 32.

General coloration of mesonotum brownish yellow to testaceous-yellow; knobs of halteres dark brown; wings with a faint brown tinge; stigma oval, a trifle darker than the ground; Sc_1 ending about opposite two-fifths the length of Rs, Sc_2 at its tip; Rs angulated and weakly spurred at origin; male hypopygium with the dorsal dististyle microscopically setulose; ventral dististyle relatively small, the rostral prolongation with two spines, the innermost from an enlarged basal tubercle.

Male.—Length, about 4 millimeters; wing, 4.8.

Rostrum obscure yellow; palpi brownish black. Antennæ with the basal segments damaged; flagellum black; flagellar segments oval. Head dark gray.

Pronotum yellowish testaceous, with long erect black setæ. Mesonotum gibbous, brownish yellow to brownish testaceous. Pleura testaceous-yellow. Halteres with the stem pale, the base yellow, the knob dark brown. Legs with the coxæ and trochanters yellow; femora testaceous-brown, the outer segments of the tarsi slightly darker. Wings (Plate 1, fig. 8) with a very faint brown tinge; stigma oval, a trifle darker brown; veins brown. Venation: Sc of moderate length, Sc_1 ending about opposite two-fifths the length of Rs, Sc_2 at its tip; Rs angulated and weakly spurred at origin; free tip of Sc_2 and R_2 in alignment; m-cu oblique, just before the fork of M, subequal to the distal section of Cu_1; anal veins parallel at origin.

Abdomen dark brown; hypopygium pale. Male hypopygium (Plate 2, fig. 32) with the caudal margin of the tergite, *9t*, strongly notched medially. Basistyle, *b*, relatively small, the mesal lobe large. Dorsal dististyle, *dd*, with the surface on basal two-thirds with microscopic setulæ. Ventral dististyle, *vd*, subequal in area to the basistyle; prolongation with two strong spines of equal length, placed close together on basal third of prolongation; inner spine from a more strongly de-

veloped tubercle than the outer spine. Gonapophyses, *g*, with the mesal-apical lobe curved, blackened.

Habitat.—Formosa (north).

Holotype, male, Urai, altitude about 1,500 feet, May 1, 1932 (*Gressitt*).

Limonia (*Limonia*) *inscita* is very different from other known species of the subgenus, as now known from the Japanese Empire. The type of hypopygium is somewhat as in *L.* (*L.*) *fusca* (Meigen), which is otherwise very different in the apically pubescent wings.

LIMONIA (EUGLOCHINA) CURTATA sp. nov. Plate 1, fig. 9.

General coloration of mesonotum shiny brown, the pleura more yellow; wings whitish subhyaline, the cells beyond cord weakly darkened; stigma oval, dark brown; Sc very short, the distance between arculus and tip of Sc_1 being shorter than the distance on R between Sc_2 and origin of Rs; Rs short, oblique; R_1 beyond Rs without further union with R_{2+3}; cell M_2 open by the atrophy of the basal section of M_3; m-cu nearly its own length beyond fork of M; vein 2d A ending distinctly beyond level of vein Sc.

Female.—Length, about 5.5 millimeters; wing, 5.8.

Rostrum and palpi brownish black. Antennæ with scape and pedicel brownish black; flagellum dark brown; antennæ relatively elongate; flagellar segments fusiform. Head brown.

Mesonotum almost uniform shiny brown, the pleura more yellowish. Halteres elongate, the stem brown, the knob brownish black. Legs with the coxæ yellow; trochanters testaceous; remainder of legs broken. Wings (Plate 1, fig. 9) whitish subhyaline, the cells beyond cord, together with the apical border, a trifle darker; stigma oval, dark brown; veins dark brown. Macrotrichia of veins long and conspicuous. Venation: Sc very short, the vein between arculus and its tip shorter than the distance on R between Sc_2 and origin of Rs; Rs very short, oblique, subequal in length to r-m, and with vein R_1 beyond it simple, without connection with R_{2+3}; basal section of R_{4+5} long and strongly arcuated; cell M_2 open by atrophy of basal section of vein M_3; m-cu nearly its own length beyond fork of M; vein 2d A ending distinctly beyond the level of end of vein Sc.

Abdomen with the segments brown, the basal portion a little brightened.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, female, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*).

Limonia (*Euglochina*) *curtata* is very different from the other described species of *Euglochina* in the whitish subhyaline wings, the very short Sc, short Rs, entire atrophy of vein R_2, and the open cell M_2. All other described species of the subgenus have Sc longer, always exceeding the distance between Sc_2 and origin of Rs; Rs much longer than r-m; R_2 present, connecting R_{1+2} with R_3; and with cell 1st M_2 closed.

HELIUS (HELIUS) COPIOSUS sp. nov. Plate 1, fig. 10; Plate 2, fig. 33.

General coloration of mesonotum dark brown; antennæ relatively long, dark brown throughout; flagellar segments cylindrical, with abundant, dense, erect setæ that are almost as long as the short verticils; wings pale yellowish subhyaline; stigma long-oval, pale brown; Sc_1 ending opposite fork of Rs; cell 1st M_2 short-hexagonal, with m-cu at midlength.

Male.—Length, including rostrum, about 6.5 millimeters; wing, 7.

Rostrum relatively long and slender, a little longer than the remainder of head, dark brown; palpi black. Antennæ relatively elongate, dark brown throughout; flagellar segments cylindrical, with abundant dense erect setæ that are almost as long as the short verticils. Head blackish, sparsely pruinose.

Mesonotum chiefly dark brown, the scutellum more testaceous. Pleura more reddish brown. Halteres yellow, the knobs weakly darkened. Legs with the fore coxæ darkened, the remaining coxæ and all trochanters yellow; femora and tibiæ pale brown, the tarsi passing into light yellow. Wings (Plate 1, fig. 10) pale yellowish subhyaline, the prearcular and costal regions a little brighter; stigma long-oval, pale brown; veins pale brown, more yellowish in the costal region. Anterior branch of Rs with relatively few macrotrichia, including about six or seven, widely scattered; other outer radial and medial veins with close, dense series of trichia; costal fringe of moderate length and very dense. Venation: Sc_1 terminating opposite fork of Rs; cell R_2 at margin narrow, subequal to m-cu; cell 1st M_2 short-hexagonal; veins issuing from cell 1st M_2 elongate; m-cu at midlength of the cell.

Abdomen dark brown; hypopygium yellow. Male hypopygium (Plate 2, fig. 33) with the basistyle, *b*, produced into a lobe on base of mesal face. Outer dististyle, *od*, short, blackened,

gently arcuated, the tip very weakly bidentate. What are presumably interbases, *i*, have the peculiar conformation shown in the figure. Ædeagus, *a*, weakly spiraliform at tip.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*).

By Edwards's synopsis of the Oriental species of *Helius* [4] the present fly runs to *Helius* (*Helius*) *kambangani* (de Meijere) and *H.* (*H.*) *fasciventris* Edwards, but differs from both in the body coloration and venation. In the two latter species, Sc is unusually long, extending almost to opposite the outer end of cell 1st M_2, which latter is of peculiar shape, with m oblique in position and longer than the basal section of M_3.

ORIMARGA (ORIMARGA) GYMNONEURA sp. nov. Plate 1, fig. 11; Plate 2, fig. 34.

General coloration dark gray; legs and antennæ black; wings grayish, very broad; wing veins unusually glabrous, there being no trichia on Rs or any of its branches; R_{2+3} about twice as long as R_2, the latter longer than R_{1+2}; male hypopygium with the outer dististyle broader and less acutely pointed than usual in the genus; inner dististyle near apex bent almost at a right angle into a slender lobe; gonapophyses and interbases appearing as slender acute spines.

Male.—Length, about 5 millimeters; wing, 5 by 1.6.

Rostrum brown; palpi black. Antennæ black throughout; flagellar segments oval. Head gray.

Mesonotum almost uniformly dark gray, the posterior sclerites more dusted with lighter gray. Pleura dark gray; dorsopleural region dark. Halteres pale, the knobs slightly dusky. Legs with the coxæ reddish, sparsely pruinose; trochanters brownish testaceous; remainder of legs brownish black. Wings (Plate 1, fig. 11) grayish, the prearcular and costal regions a trifle brighter; veins dark brown. Wings very broad, as shown by the measurements; macrotrichia of veins unusually sparse, there being none on any of the veins beyond level of fork of Rs, excepting two or three near outer ends of each of veins M_{1+2} and M_3; none on Rs or its branches. Venation: Sc_1 ending shortly before fork of Rs, Sc_2 at its tip; R_{2+3} about twice R_2, the latter longer than R_{1+2}; r-m lying slightly beyond level of R_2; m-cu opposite midlength of Rs; cell 2d A long-extended, its outer end opposite or shortly beyond m-cu.

[4] Journ. Fed. Malay St. Mus. 14 (1928) 85–86.

Abdomen dark reddish brown, the sternites a little brighter; hypopygium a little brighter. Male hypopygium (Plate 2, fig. 34) with the outer dististyle, *od*, much broader and less acutely pointed than is usual in the genus; inner dististyle, *id*, near apex bent almost at a right angle into a slender lobe. Gonapophyses, *g*, and interbases, *i*, appearing as slender acute spines, the tips narrowly pale.

Habitat.—Formosa (south).

Holotype, male, Keinensan, altitude 5,400 feet, August 14, 1933 (*Issiki*).

The unusually glabrous veins and the very broad wings will readily separate the present fly from all other species of *Orimarga* in eastern Asia.

ORIMARGA (ORIMARGA) GRISEIPENNIS sp. nov. Plate 1, fig. 12.

General coloration of notum dark brown, grayish pruinose; rostrum obscure yellow; antennæ black throughout; legs black; wings grayish; macrotrichia on veins beyond cord relatively numerous; R_{2+3} fully one-half longer than R_2; petiole of cell M_3 relatively long, exceeding vein M_4; basal portion of vein M_3 distinctly preserved; m-cu nearly opposite midlength of Rs; abdomen reddish brown.

Female.—Length, about 5 millimeters; wing, 4.4.

Rostrum obscure yellow; palpi black. Antennæ black throughout; flagellar segments oval; verticils inconspicuous. Head dark gray.

Mesonotal præscutum and scutum dark brown, sparsely pruinose; scutellum reddish, very sparsely pruinose; mediotergite light gray. Pleura almost uniformly reddish yellow. Halteres pale, the base of stem yellow, the knobs weakly dusky. Legs with the coxæ reddish; trochanters more testaceous; remainder of legs black, the femoral bases restrictedly or scarcely brightened. Wings (Plate 1, fig. 12) grayish, the prearcular and costal regions more yellowish white; veins brown, slightly seamed with brown to produce a slight streaked appearance. Macrotrichia of veins beyond cord relatively abundant, there being close series on all of R_3 except the basal fourth; all of outer section of R_{4+5}, and on basal section of the latter except for the slightly deflected basal portion; on outer section of M_{1+2} except the basal fifth; on entire lengths of veins M_3 and M_4. Venation: Sc_1 ending beyond midlength of Rs, Sc_2 at its tip; no trace of the free tip of Sc_2; R_{2+3} about one-half longer than R_2, the latter a little shorter than R_{1+2}; petiole of cell M_3 long,

exceeding vein M_4 in length; base of vein M_3 distinctly preserved; m-cu with its cephalic end nearly opposite mid-length of Rs.

Abdomen reddish brown throughout.

Habitat.—Formosa (south).

Holotype, female, Tyusinron, altitude 3,200 feet, August 18, 1933 (*Issiki*).

The nearest ally seems to be *Orimarga* (*Orimarga*) *taiwanensis* Alexander, which differs most evidently in the more brownish yellow wings, with the venational detail different, especially the position of m-cu and the short petiole of cell M_3.

ORIMARGA (ORIMARGA) TOALA sp. nov. Plate 1, fig. 13.

General coloration of thorax dark plumbeous gray; rostrum, palpi, and antennæ black; wings tinged with gray; macrotrichia of veins very sparse, quite lacking on veins R_{1+2}, R_2, R_{2+3}, and R_3; R_{1+2} very short, not exceeding one-half R_2; r-m and basal section of M_{1+2} in transverse alignment; cell M_3 about one-half longer than its petiole; abdomen brownish black.

Female.—Length, about 4.5 millimeters; wing, 4.5.

Rostrum black, paler ventrally; palpi black. Antennæ black throughout; flagellar segments suboval, with dense pubescence. Head plumbeous gray.

Mesonotum uniformly dark plumbeous gray. Pleura gray, the ventral pleurites a little more reddish. Halteres pale, the knobs weakly dusky. Legs with the fore coxæ dark gray, the remaining coxæ testaceous gray; trochanters testaceous yellow; remainder of legs more yellowish brown, especially the tarsi. Wings (Plate 1, fig. 13) tinged with grayish; veins pale brown. Macrotrichia of veins very sparse, there being none on Rs, R_{1+2}, R_2, R_{2+3}, or R_3; on R_{4+5}, with a series of about fifteen on distal half of outer section; a restricted series on outer ends of veins M_{1+2} and M_3. Venation: Sc_1 ends about opposite five-sixths the length of Rs, Sc_2 a short distance from its tip; R_{1+2} very short, not exceeding one-half R_2; basal section of R_{4+5} strongly angulated on basal third; r-m and basal section of M_{1+2} in transverse alignment; cell M_3 about one-half longer than its petiole; m-cu opposite the basal third of Rs.

Abdomen brownish black, the sternites a trifle paler.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, female, Latimodjong Mountains, altitude 3,800 feet, May 15, 1931 (*Clagg*). Paratopotype, female.

Orimarga (*Orimarga*) *toala* is named after a tribe of aborigines inhabiting Celebes. Its nearest ally appears to be *O.* (*O.*)

borneensis Brunetti, with which it agrees in the general appearance and venation, as the very short R_{1+2}. The latter species is well-distinguished from *toala* by details of venation, as the elongate Rs and the arcuated basal section of M_{1+2}, which is much longer than r-m and not in alignment with it; and by the more abundant and conspicuous macrotrichia of the radial veins, including a series of about fifteen distributed over almost the whole length of vein R_3.

ORIMARGA (ORIMARGA) HYPOPYGIALIS sp. nov. Plate 1, fig. 14; Plate 2, fig. 35.

General coloration brownish gray, the præscutum more blackened medially; wings with a faint brown tinge; macrotrichia of outer radial and medial veins dense and abundant; Rs short and angulated at origin; R_{1+2} long, approximately three times R_2 and nearly as long as R_{2+3}; cell M_3 deep; male hypopygium with the tergite conspicuous, deeply emarginate, the lobes broadly rounded and without specially modified setæ; lobe of basistyle tapering to a narrow point, with numerous fasciculate setæ.

Male.—Length, about 5 millimeters; wing, 6.

Rostrum and palpi black. Antennæ black throughout. Head dark gray, the anterior vertex somewhat brighter.

Mesonotal præscutum brownish gray, the median stripe blackish, somewhat polished; lateral stripes poorly indicated; posterior sclerites of notum gray. Pleura blackish, sparsely pruinose. Halteres pale. Legs with the coxæ brownish black, the fore coxæ somewhat darker; trochanters brownish black; remainder of legs dark brown or brownish black. Wings (Plate 1, fig. 14) with a faint brown tinge; veins brown. Macrotrichia of veins relatively abundant, including a series of about twelve on R_{1+2} and more than fifty on R_3 alone; complete dense series of trichia on all outer branches of R and M. Venation: Rs short and angulated near origin; R_{1+2} long, approximately three times R_2 and nearly as long as R_{2+3}; cell M_3 deep, M_{3+4} being about two-thirds M_4; m-cu just beyond the level of the bend of Rs.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 2, fig. 35) of the general type of *quadrilobata*, differing especially in the broad lobes of the tergite, *9t*, which are evenly rounded and without a group of specially modified setæ on their internal margin, and in the narrow lobe of the basistyle, *b*. Both species have the dististyles of approximately

the same conformation and with the abundant setæ of the lobe of the basistyle strongly fasciculate.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 5,800 feet, May 24, 1931 (*Clagg*).

The closest ally of the present fly is undoubtedly *Orimarga* (*Orimarga*) *quadrilobata* Alexander (Mindanao), which differs in the venation, especially the short R_{1+2}, and in the details of the structure of the male hypopygium, as the conformation of the tergite and lobe of the basistyle. *Orimarga* (*O.*) *fryeri* Edwards (Seychelles Islands) and *O.* (*O.*) *flaviventris* Edwards (Key Islands) likewise have hair brushes on the basistyle of the hypopygium but are otherwise very different flies.

HEXATOMINI

EPIPHRAGMA (POLYPHRAGMA) MINAHASSANA sp. nov. Plate 1, fig. 15; Plate 3, fig. 36.

Belongs to the *ochrinota* group; mesonotum reddish brown, the surface very sparsely pruinose; pleura brownish black; darkened femoral ring pale brown; wings with a brown pattern that is narrowly bordered by yellow; male hypopygium with the interbase a simple rod, on outer fifth angularly bent to an acute point.

Male.—Length, about 7.5 millimeters; wing, 8.3.

Female.—Length, about 6.5 to 7 millimeters; wing, 6 to 6.5.

Rostrum and palpi brownish black. Antennæ with the scape brown, sparsely pruinose; pedicel and first two flagellar segments light orange-yellow; outer flagellar segments brown. Front and anterior vertex ashy gray; posterior vertex dark brown on central area, the lateral and orbital portions more fulvous.

Mesonotal præscutum and scutum reddish brown, the surface very sparsely pruinose; scutellum and mediotergite dark brown, sparsely pruinose. Pleura brownish black, immaculate, contrasting abruptly with the pale notum. Halteres with the stem yellow, narrowly darkened at extreme base, the knob infuscated. Legs with the fore and middle coxæ brownish yellow; posterior coxæ blackened; trochanters yellow; femora yellow, darkened to a pale brown subterminal ring, the tip again light yellow; tibiæ and tarsi yellow. Wings (Plate 1, fig. 15) with the ground color pale brown, variegated by darker brown spots and broken crossbands that are narrowly bordered by pale yellow; prearcular and costal regions yellow; cell C with about ten dark areas, some of which inclose spurs of crossveins; longitudinal veins at margin with brown spots, the ends of the correspond-

ing cells with yellow areas, more intense in the radial field; veins brown, more luteous in the costal field. Venation: R_{2+3+4} shorter than m-cu, the latter about one-half its length beyond the fork of M.

Abdomen dark brown, in male with intermediate portions of the sternites a little more yellowish. Male hypopygium (Plate 3, fig. 36) with the lobes of the tergite, *9t*, slender, separated by a U-shaped notch. Dististyles, *id*, *od*, relatively small. Interbase, *i*, a long, powerful, simple rod, on outer fifth bent at an angle to the acute point.

Habitat.—North Celebes (Minahassa).

Holotype, male, Roeroekan, altitude 4,000 feet, April 18, 1931 (*Clagg*). Allotopotype, female. Paratopotype, female.

In my key to the species of *Polyphragma* [5] the present fly runs to *Epiphragma* (*Polyphragma*) *ochrinota* Alexander (Luzon), which is its nearest ally. The fly is most readily told by the hypopygial structures, especially of the tergite and interbase. The subgenus had previously been recorded only from Luzon, Mindanao, and Borneo.

LIMNOPHILA (TRICHOLIMNOPHILA) FEROCIA sp. nov. Plate 1, fig. 16; Plate 3, fig. 37.

General coloration of mesonotum opaque grayish brown, the præscutum without evident stripes; antennæ (male) elongate; femora obscure yellow; wings strongly tinged with brown, the base unbrightened; restricted darker brown seams at origin of Rs and along cord and outer end of cell 1st M_2; abdominal tergites dark brown, sternites brownish yellow; male hypopygium with the median lobe of tergite long and narrow, parallel-sided, the apex truncated; outer dististyle without spinous points on surface; phallosome with the gonapophyses simple, each appearing as a flattened, twisted blade that exceeds the ædeagus in length.

Male.—Length, about 5 millimeters; wing, 5.5 to 5.6; antenna, about 2.7.

Rostrum brownish black; palpi black. Antennæ (male) relatively elongate, as shown by the measurements, the individual segments a little longer than in *platystyla;* scape and pedicel brownish yellow; flagellum black, the extreme base of the first segment restrictedly pale; flagellar segments with verticils that are subequal in length to the segments. Head grayish brown.

[5] Philip. Journ. Sci. 49 (1932) 259–261.

Mesonotum opaque grayish brown, without evident stripes. Pleura dark grayish brown. Halteres with stem yellow, the knob dusky. Legs with fore coxæ brown, the remaining coxæ and all trochanters light yellow; femora obscure yellow; tibiæ brownish yellow, the tips narrowly dark brown; tarsi brownish black. Wings (Plate 1, fig. 16) strongly tinged with brown, the color uniform throughout except for darker brown areas at origin of Rs, Sc_2, stigma, cord, and outer end of cell 1st M_2; veins brown, somewhat darker in the infuscated areas. Macrotrichia in outer ends of cells R_2 to M_4, inclusive, more numerous in outer ends of the cells. Venation: Sc_1 longer than m-cu; R_2 pale but distinct, about one-half R_{1+2}; petiole of cell M_1 approximately one-half the cell; m-cu about one-third its length beyond the fork of M.

Abdominal tergites dark brown; sternite brownish yellow. Male hypopygium (Plate 3, fig. 37) with the median lobe of tergite, *9t*, long and narrow, the sides nearly parallel, the lateral portions more deflexed; from each outer lateral angle with a strong ridge directed cephalad. Apex of basistyle, *b*, narrowed into a glabrous subacute point. Outer dististyle, *od*, strongly flattened, as in *platystyla*, the surface much wrinkled but without spinous points, as in *platystyla* and its variety *parallela*. Inner dististyle, *id*, with the inner or cephalic lobe very small and weak. Phallosome with the gonapophyses, *g*, simple, each appearing as a flattened, twisted blade that is longer than the ædeagus, *a*.

Habitat.—Formosa (north).

Holotype, male, Sozan, altitude 1,000 feet, December 5, 1933 (*Issiki*). Paratopotypes, 2 males.

Limnophila (*Tricholimnophila*) *ferocia* is allied to *L.* (*T.*) *platystyla* Alexander and its race, *L.* (*T.*) *platystyla parallela* Alexander, likewise from Formosa, differing most evidently in the distinct structure of the male hypopygium, especially the glabrous outer dististyle, and the simple, very large and conspicuous gonapophyses. In the two forms listed, the latter structure is a profoundly bifid rod, the arms appearing as slender spines. The male sex of *L.* (*T.*) *excelsa* Alexander, from the high mountains of Formosa, is still unknown, but from the coloration it cannot be identical with the present fly.

ELEPHANTOMYIA (ELEPHANTOMYODES) INFUMOSA sp. nov. Plate 1, fig. 17.

General coloration of mesonotum dull brownish orange to reddish brown; head dark brown or brownish black; legs dark

brown, the tarsi extensively snowy white; wings strongly suffused with brown but otherwise unmarked except for the darker stigmal area; abdomen feebly bicolorous.

Male.—Length, excluding rostrum, about 6 to 7 millimeters; wing, 6.5 to 7.5; rostrum, about 4.5 to 5.5.

Female.—Length, excluding rostrum, about 6 millimeters; wing, 5.5; rostrum, about 3.5.

Rostrum dark brown, longer in male. Antennæ black throughout. Head dark brown to brownish black, the inner orbits very narrowly grayish.

Mesonotal præscutum dull brownish orange to reddish brown, in female narrowly darker brown on the median area; scutum and scutellum dull brownish orange, the mediotergite somewhat darker brown. Pleura dull brown. Halteres brownish black, the base of stem restrictedly paler, the knob more blackened. Legs with the coxæ brown; trochanters obscure yellow; femora and tibiæ dark brown; basitarsi chiefly dark brown, the narrow tips and all of segments two and three snowy white; outer tarsal segments darkened. Wings (Plate 1, fig. 17) uniformly suffused with brown but otherwise unmarked except for the darker stigmal area; veins brownish black. Venation: m-cu at from one-third to one-half the length of cell 1st M_2; vein 2d A relatively long, ending at midlength of wing.

Abdomen feebly bicolorous, the tergites dark brown, the basal rings of segments three to five narrowly yellow; sternites more diffusely patterned; outer abdominal segments and hypopygium brownish black.

Habitat.—Northern Celebes (Minahassa).

Holotype, male, Mount Rumengan, Roeroekan, altitude 4,000 feet, April 13, 1931 (*Clagg*); mating on leaf of *Pandanus*. Allotopotype, female, in copula with type. Paratopotypes, 2 males.

In its combination of brownish black head, white tarsi, and unpatterned wings, the present fly is most nearly allied to *Elephantomyia* (*Elephantomyodes*) *nigriceps* Edwards (Siam, Borneo), *E.* (*E.*) *nigriclava* Edwards (Borneo), and *E.* (*E.*) *samarensis* Alexander (Philippines), differing from all in the strongly suffused wings.

ERIOPTERINI

TRENTEPOHLIA (TRENTEPOHLIA) PROBA sp. nov. Plate 1, fig. 18.

General coloration brownish black; humeral region of præscutum a little more reddish brown; knobs of halteres brownish black; wings with the ground color whitish, cross-banded with

dark brown; pale band beyond cord almost parallel-sided, only slightly constricted at midlength; no pale spots in outer ends of cells R, M, and Cu; Rs shorter than R_{2+3+4}; R_2 subequal to R_{3+4}; m-cu just beyond fork of M.

Female.—Length, about 7 millimeters; wing, 7.

Rostrum black; palpi brown. Antennæ with the scape black, pedicel dark brown; flagellum broken. Head brownish black; vertex narrowed at a single point.

Pronotum and cervical sclerites black. Mesonotum dull brownish black, the humeral region of præscutum a little more reddish brown. Pleura brownish black, including the dorsopleural region. Halteres yellow, the knobs brownish black. Legs with the coxæ brownish black; trochanters obscure brownish yellow; remainder of legs broken. Wings (Plate 1, fig. 18) with the ground color whitish, cross-banded with dark brown; prearcular region and costal interspaces pale yellow; band of the ground color lying beyond cord almost parallel-sided and thus only slightly constricted along vein R_{4+5} and M_{1+2}; darkened apex variegated by a white spot in outer ends of cells R_3 and R_4; grayish washes in base of cell R_5 and outer end of cell M_2; outer ends of cells in medial dark band not variegated by pale spots, as in *pulchripennis;* veins brown, pale yellow in the clear areas. Venation: Sc_1 ending beyond fork of M; Rs shorter than R_{2+3+4}; R_2 subequal to R_{3+4}; veins R_3 and R_4 only slightly divergent, the former rather strongly upcurved at costa; m-cu just beyond fork of M.

Abdomen black; ovipositor and genital segment orange.

Habitat.—Formosa (north).

Holotype, female, Urai, altitude about 1,500 feet, May 1, 1932 (*Gressitt*).

Trentepohlia (*Trentepohlia*) *proba* is most nearly allied to *T.* (*T.*) *pulchripennis* Alexander (Formosa), which differs especially in the smaller size, light yellow to brownish yellow mesonotum, yellowish sternum and dorsopleural region, and the distinct venation, especially the long R_{3+4} which is subequal to the nearly erect R_3, and the distal position of the fork of M, with m-cu lying more than one-half its length before this fork.

GONOMYIA (LIPOPHLEPS) MITOPHORA sp. nov. Plate 1, fig. 19; Plate 3, fig. 38.

Belongs to the *skusei* group; mesonotal præscutum with three black or brownish black stripes that are confluent or nearly so; pleura reddish yellow to testaceous-yellow; legs dark brown; wings with a faint brown tinge; Sc relatively short for a mem-

ber of the group, Sc_1 ending shortly beyond origin of Rs; male hypopygium with the outer lobe of basistyle unusually long, cylindrical; dististyles of the two sides slightly asymmetrical.

Male.—Length, about 4.5 to 5 millimeters; wing, 4.5 to 5.

Female.—Length, about 5.5 to 6 millimeters; wing, 5 to 5.3.

Rostrum and palpi black. Antennæ black throughout; flagellar segments (male) with elongate verticils, as in the group. Head dark.

Pronotum darkened medially, yellow on sides. Mesonotal præscutum chiefly covered by black or brownish black stripes that are nearly or quite confluent, reducing or obliterating the usual interspaces; scutal lobes almost covered by black areas, the broad median region and the scutellum pale yellow; mediotergite reddish yellow. Pleura uniformly reddish yellow to testaceous-yellow, without distinct stripes. Halteres pale yellow, the base of knob a trifle darkened. Legs with the coxæ obscure yellow, the fore coxæ a trifle darker; trochanters yellow; remainder of legs uniformly dark brown. Wings (Plate 1, fig. 19) with a faint brown tinge, the stigmal area scarcely darkened; veins pale brown. Venation: Sc_1 ending a trifle beyond the origin of Rs, Sc_2 opposite or close to this origin; basal section of R_5 of variable length, in cases very much reduced; branches of Rs elongate, more or less parallel on basal third; cell 1st M_2 closed; m-cu at or beyond the fork of M.

Abdominal tergites brownish yellow, the sternites more yellowish, with a more or less definite median darkening; hypopygium relatively large and conspicuous. Male hypopygium (Plate 3, fig. 38) with the outer lobe of basistyle, *b*, unusually long and slender, cylindrical, pale, with long erect setæ on mesal face. Distityles, *d*, of the two sides slightly asymmetrical, in one the apical spine long and slender, gently sinuous, on the opposite side the corresponding spine shorter, more flattened, sinuous. Phallosome, *p*, a flattened compressed blade, bearing a large spinous point on basal third where the structure is strongly narrowed, thence dilated into a spatula.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 3,800 feet, May 15, 1931 (*Clagg*). Allotopotype, female. Paratopotypes, 12 of both sexes, May 15–16, 1931.

Gonomyia (*Lipophleps*) *mitophora* is readily told from all allied species of the subgenus by the coloration, venation, and structure of the male hypopygium. I am referring it to the

skusei group, despite the relatively short Sc which, in some cases, extends only to a slight distance beyond the origin of Rs.

GONOMYIA (LIPOPHLEPS) PERVILIS sp. nov. Plate 1, fig. 20; Plate 3, fig. 39.

Allied to *diacantha;* male hypopygium with the outer dististyle stout on basal half, the outer portion produced into a long smooth rod, at base on mesal edge with two blackened spines; cephalic-mesal portion of style further produced into a slender darkened rod; inner dististyle terminating in a relatively short spine; phallosome consisting chiefly of two flattened pale blades.

Male.—Length, about 3 millimeters; wing, 3.8.

Rostrum and palpi black. Antennæ chiefly black, the pedicel a little brightened. Head chiefly dark gray.

Pronotum and anterior lateral pretergites pale yellow. Mesonotum chiefly gray, the humeral region of præscutum restrictedly brightened; scutellum vaguely brightened on basal portion. Pleura dark, with a conspicuous silvery white longitudinal stripe extending from behind the fore coxæ to the meral region. Halteres dusky, the knobs obscure yellow. Legs with the fore coxæ brownish yellow; remaining coxæ darker; trochanters brownish testaceous; femora pale brown, the bases a little brightened, the tips narrowly darker brown; tibiæ and tarsi dark brown; femora with a row of evenly spaced erect setæ on ventral face, longer and more conspicuous on posterior femora. Wings (Plate 1, fig. 20) whitish subhyaline, clouded with darker, including major areas in all basal cells, especially R, along cord and in outer radial field; stigma long-oval, dark brown; veins brown, more yellowish in the ground areas. Venation: Sc_1 ending a short distance before the origin of Rs, the degree a little shorter than m-cu; anterior branch of Rs paralleling R_1; r-m long, arcuated; m-cu before the fork of M.

Abdomen dark brown; hypopygium yellow. Male hypopygium (Plate 3, fig. 39) with the outer dististyle, *od,* stout on basal portion, the outer part produced into a long, gently arcuated rod, its tip obtuse, the margin smooth; at base of this rod, on inner aspect with two blackened spines, the mesal one a little longer; on mesal face of style near base a further slender dark arm that bears a small subapical spine. Inner dististyle, *id,* with the apical spine short. Phallosome, *p,* appearing chiefly as two flattened pale blades that fill the whole genital chamber.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 3,800 feet, May 17, 1931 (*Clagg*).

Gonomyia (*Lipophleps*) *pervilis* is most nearly allied to *G.* (*L.*) *diacantha* Alexander (Mindanao), differing conspicuously in the structure of the phallosome and outer dististyle.

GONOMYIA (LIPOPHLEPS) GRESSITTI sp. nov. Plate 3, fig. 40.

Belongs to the *diffusa* group; male hypopygium with three dististyles, the intermediate one a long simple pale spine; inner style widely separated from the outer, appearing as a flattened blade that is narrowed on outer third into a slenderer blade whose base is surrounded by several setæ.

Male.—Length, about 3 millimeters; wing, 3.5.

Rostrum and palpi dark. Antennæ with scape dark; remainder of antennæ broken. Head chiefly dark.

Anterior lateral pretergites light yellow. Mesonotal præscutum and scutum brownish gray; humeral region of the former restrictedly paler; scutal lobes with posterior callosities light yellow; scutellum with posterior border broadly pale yellow. Pleura chiefly dark brown with a conspicuous silvery white longitudinal stripe, extending from above the fore coxæ to the base of abdomen. Legs with the femora obscure yellow, with a broad black terminal (forelegs) to nearly terminal ring; tibiæ obscure yellow, the bases and tips narrowly blackened; basitarsi obscure brownish yellow, the tips and remainder of tarsi black. Wings with a faint grayish tinge; stigma barely evident; veins pale brown. Venation: Sc relatively long, Sc_1 ending shortly before origin of Rs, Sc_2 close to its tip; anterior branch of Rs nearly straight and extending nearly parallel to R_1; m-cu shortly before the fork of M.

Abdominal tergites black, the caudal borders of the segments narrowly yellow. Male hypopygium (Plate 3, fig. 40) of the general type of *jacobsoniana* or *ramifera*, differing in all details. Outer dististyle, *od*, a gently arcuated simple rod; intermediate style, *md*, nearly as long, appearing as a slender pale needlelike spine; inner style, *id*, placed low down on the mesal face of basistyle, as in the group, appearing as a flattened blade, on about the outer third suddenly narrowed into a slenderer blade, at base of the latter with a group of several coarse setæ; base of inner style on cephalic portion with a group of setæ.

Habitat.—Formosa (south).

Holotype, male, Rokki, near river, altitude 400 to 500 feet, June 14, 1932 (*Gressitt*).

I take great pleasure in naming this distinct species in honor of the collector, Mr. J. Linsley Gressitt, to whom I am indebted

for several interesting Tipulidæ from Honshiu and Formosa. The nearest allies are *Gonomyia* (*Lipophleps*) *jacobsoniana* Alexander and *G.* (*L.*) *ramifera* Alexander (Sumatra to Mindanao), which differ most evidently in the structure of the male hypopygia.

ORMOSIA DIVERSIPENNIS sp. nov. Plate 1, fig. 21.

Mesonotal præscutum and scutum light brown, the posterior sclerites of mesonotum and the pleura darker brown; knobs of halteres light yellow; legs yellow, the femora with a narrow brown subterminal ring and indications of a broader but more diffuse annulus before midlength; wings buffy yellow, variegated over the entire surface by abundant patches of dark-colored trichia; outer ends of marginal cells yellow; abdomen dark brown.

Female.—Length, about 4 millimeters; wing, 4.8.

Rostrum brown; palpi brownish black. Antennæ brown, the flagellar segments vaguely bicolorous by having their apices slightly pale. Head dark brown, with conspicuous yellow setæ.

Mesonotal præscutum light brown, without markings; pseudosutural foveæ black, the tuberculate pits small and paler; setæ of interspaces yellow, long, and conspicuous; scutum light brown; scutellum and mediotergite darker brown, with indications of a dark median dash on scutum and scutellum. Pleura darker brown than the præscutum. Halteres pale, the knobs large, light yellow. Legs with the coxæ brown; trochanters brownish yellow; femora yellow, with a narrow brown subterminal ring; most of the femora are also more or less darkened on basal half, leaving a broad ring of the ground color at and beyond midlength; tibiæ and tarsi light yellow, the outer tarsal segments darker. Wings (Plate 1, fig. 21) with the ground color buffy yellow, the costal and apical borders extensively brighter yellow; entire surface of wing variegated by large patches of dark-colored trichia, these occurring in almost all cells; trichia elsewhere on disk light yellow, the total area of light and dark patches being not greatly disproportionate; conspicuous yellow areas at ends of all marginal cells; veins yellow, darker in the clouded areas. Macrotrichia of cells long and conspicuous. Venation: Tips of veins R_3 and R_4 strongly deflected cephalad; cell 1st M_2 open by atrophy of basal section of M_3.

Abdomen dark brown. Valves of ovipositor long and conspicuous, dark horn-color.

Habitat.—Formosa (south).

Holotype, female, Sekisan, altitude 6,000 feet, August 15, 1933 (*Issiki*).

Ormosia diversipennis is readily told from allied regional species of the genus by the pattern of the wings and legs, especially the former.

CRYPTOLABIS (BÆOURA) CONSOCIA sp. nov. Plate 1, fig. 22; Plate 3, fig. 41.

General coloration dark gray; antennæ black throughout; legs black, the setæ not conspicuously outspreading; scutellum behind broadly yellow; male hypopygium with the dististyle strongly narrowed on outer half into a fingerlike lobe; gonapophysis a flattened blade that bears two large triangular points.

Male.—Length, about 4.5 millimeters; wing, 4.8.

Rostrum dark above, yellow laterally; basal segments of palpi obscure yellow, the outer segments blackened. Antennæ black throughout, the scape a little pruinose; pedicel larger than the scape; basal flagellar segments short-oval to subcylindrical, the outer segments more elongate, with conspicuous verticils. Head light gray.

Pronotum brownish gray, narrowly yellow on sides. Anterior lateral pretergites yellow, variegated by dark brown spots. Mesonotal præscutum dark gray, with indications of a darker median stripe; scutum similarly darkened, the outer lateral portions more yellow; scutellum dark basally, the margin broadly yellow; mediotergite gray. Pleura gray; dorsopleural membrane paler. Halteres dusky. Legs with the coxæ dark; trochanters brownish testaceous; remainder of legs black, with chiefly yellow setæ of moderate length. Wings (Plate 1, fig. 22) with a grayish tinge, the prearcular and costal regions more nearly whitish; stigma faintly indicated; scarcely evident darkenings along cord; veins brown. Venation: Sc_1 ending just before R_2, Sc_2 some distance from its tip; R_3 lying close to R_{1+2}, a little constricting the cell before midlength; m-cu more than three-fourths its length beyond the fork of M; cell 2d A wide.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 3, fig. 41) with the tergite, *9t*, conspicuous, the outer lateral angles appearing as glabrous, obtuse, earlike lobes. Dististyle, *d*, with the outer half strongly narrowed into a fingerlike lobe. Gonapophyses, *g*, appearing as pale yellow flattened blades, with two strong triangular points, the lateral point or spine larger than the apical one; outer margin of outer point and lower margin of lateral one with microscopic denticles.

Habitat.—Formosa (central).

Holotype, male, Heiganzan to Pianan-Anbu, Taichû-shû, July 19, 1932 (*Esaki*).

Cryptolabis (*Bæoura*) *consocia* is most nearly allied to *C.* (*B.*) *aliena* (Alexander), differing especially in the details of structure of the male hypopygium. The hypopygium of *aliena* is shown for comparison (Plate 3, fig. 42), the most conspicuous differences being the more evident ears of the tergite, 9*t*, the longer apical point of the dististyle, *d*, and, especially, the differently shaped gonapophyses, *g*, with the outer point or lobe obtuse and microscopically roughened, the lateral point a very long and slender, gently arcuated blade.

CRYPTOLABIS (BÆOURA) LÆVILOBATA sp. nov. Plate 1, fig. 23; Plate 3, fig. 43.

General coloration of thorax and abdomen dull black; head light gray; setæ of legs long and conspicuous, erect; wings almost uniformly tinged with blackish, the apical cells paler; male hypopygium with the tergite strongly narrowed outwardly, terminating in two slender glabrous lobes that are separated from one another only by a deep U-shaped notch, the margins of the lobes smooth; fused gonapophyses with a median lobule between the short fleshy arms.

Male.—Length, about 4 millimeters; wing, 4.6.

Female.—Length, about 4 millimeters; wing, 5.4.

Rostrum dark brown; palpi black. Antennæ black throughout. Head light gray.

Mesonotum almost entirely deep black, only moderately polished; scutellum obscure yellow. Pleura dull black. Halteres with the stem dark, the base narrowly pale, the knob yellow. Legs with the coxæ and trochanters brownish black; remainder of legs brownish black, conspicuously hairy. Wings (Plate 1, fig. 23) with an almost uniform blackish tinge, the apex narrowly paler; stigma appearing as a linear darkened seam on R_{1+2}; veins and macrotrichia black. Venation: Sc_1 ending shortly beyond the fork of Rs, Sc_2 some distance before this fork; R_{2+3} a trifle longer than R_2 alone; m-cu close to midlength of M_{3+4}.

Abdomen dull black, including the genitalia of both sexes. Male hypopygium (Plate 3, fig. 43) with the ninth tergite, 9*t*, strongly narrowed outwardly, terminating in two slender glabrous lobes that are separated from one another only by a deep and narrow U-shaped notch; margins of the lobes smooth and without setæ. Dististyle, *d*, shorter than in *trichopoda*. What

are interpreted as being gonapophyses, *g*, appear as two short divergent arms, with the median area produced to lie beyond the level of these arms.

Habitat.—Formosa (north).

Holotype, male, Rimozan, May 2, 1933 (*Issiki*). Allotopotype, female.

The nearest ally of the present fly is undoubtedly *Cryptolabis* (*Bæoura*) *trichopoda* Alexander (southern Formosa) which, while very similar in general appearance, yet is conspicuously different in the structure of the hypopygium. It should be noted that these two species have the internal structures of the hypopygium very different from the other Formosan species, the large and prominent gonapophyses of *aliena* Alexander and *consocia* sp. nov., here being lacking or greatly reduced in size, or else being represented by the fused median structure (Plate 3, fig. 43, *g*), which would then form a phallosomic structure similar to that found in the genus *Molophilus*.

CRYPTOLABIS (BÆOURA) TRICHOPODA HASSENENSIS subsp. nov. Plate 3, fig. 44.

Male.—Length, about 4 millimeters; wing, 4.6.

Characters as in typical *trichopoda* Alexander, differing especially in slight details of structure of the male hypopygium (Plate 3, fig. 44). Ninth tergite, *9t*, with the lateral lobes very conspicuous, separated by a U-shaped notch, the flattened margins of the lobes with delicate serrations. Dististyle, *d*, more evenly curved.

Habitat.—Formosa (central).

Holotype, male, Hassenzan, Kahodai to Reimei, Taichû-shû, July 12, 1932, (*Esaki*).

MOLOPHILUS CELEBESICUS sp. nov. Plate 1, fig. 24; Plate 3, fig. 45.

Belongs to the *gracilis* group and subgroup; general coloration black; antennæ (male) of moderate length, brownish black throughout; wings very strongly tinged with brownish black; male hypopygium with all lobes of basistyle obtuse at tips; outer dististyle a slender, nearly straight rod, the outer end microscopically roughened; inner dististyle of similar length but broader, at near two-thirds the length with the margin produced into an acute blackened spine.

Male.—Length, about 3.8 to 4 millimeters; wing, 4.6 to 4.8.

Rostrum and palpi black. Antennæ (male) moderately elongate, if bent backward extending to the wing root, brownish black throughout. Head black, with a sparse pruinosity.

Mesonotum black, the anterior lateral pretergites restrictedly more reddish brown. Pleura dull black. Halteres brownish black. Legs brownish black throughout. Wings (Plate 1, fig. 24) very strongly suffused with brownish black; veins a little darker than the ground color; macrotrichia unusually long and conspicuous. Venation: R_2 lying shortly beyond the level of r-m; vein 2d A extending to about opposite the basal fifth of the petiole of cell M_3.

Abdomen, including the hypopygium, black. Male hypopygium (Plate 3, fig. 45) with all lobes of basistyle, *b*, obtuse, unarmed with spinous points. Outer dististyle, *od*, a small, slender, nearly straight rod, its outer end microscopically roughened. Inner dististyle, *id*, of about the same length as the outer, appearing as a straight flattened rod, at near two-thirds the length with the margin produced into an acute black spine, surrounding the base of which are several delicate setæ, additional to the rather numerous setigerous punctures elsewhere on the sclerite.

Habitat.—Central Celebes (Bontoe Batoe District).

Holotype, male, Latimodjong Mountains, altitude 4,500 to 6,000 feet, May 25, 1931 (*Clagg*). Paratopotypes, 3 males.

Molophilus celebesicus is very different from all other black species of the genus in the structure of the male hypopygium, more especially of the inner dististyle.

ILLUSTRATIONS

[*a*, Ædeagus; *b*, basistyle; *d*, dististyle; *dd*, dorsal dististyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *md*, intermediate dististyle; *od*, outer dististyle; *p*, phallosome; *t*, tergite; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Tipula* (*Lunatipula*) *multibarbata* sp. nov., venation.
2. *Dolichopeza* (*Nesopeza*) *toala* sp. nov., venation.
3. *Dolichopeza* (*Nesopeza*) *profundemarginata* sp. nov., venation.
4. *Dolichopeza* (*Nesopeza*) *toraja* sp. nov., venation.
5. *Limonia* (*Libnotes*) *falsa* sp. nov., venation.
6. *Limonia* (*Libnotes*) *comissabunda* sp. nov., venation.
7. *Limonia* (*Limonia*) *alopecura* sp. nov., venation.
8. *Limonia* (*Limonia*) *inscita* sp. nov., venation.
9. *Limonia* (*Euglochina*) *curtata* sp. nov., venation.
10. *Helius* (*Helius*) *copiosus* sp. nov., venation.
11. *Orimarga* (*Orimarga*) *gymnoneura* sp. nov., venation.
12. *Orimarga* (*Orimarga*) *griseipennis* sp. nov., venation.
13. *Orimarga* (*Orimarga*) *toala* sp. nov., venation.
14. *Orimarga* (*Orimarga*) *hypopygialis* sp. nov., venation.
15. *Epiphragma* (*Polyphragma*) *minahassana* sp. nov., venation.
16. *Limnophila* (*Tricholimnophila*) *ferocia* sp. nov., venation.
17. *Elephantomyia* (*Elephantomyodes*) *infumosa* sp. nov., venation.
18. *Trentepohlia* (*Trentepohlia*) *proba* sp. nov., venation.
19. *Gonomyia* (*Lipophleps*) *mitophora* sp. nov., venation.
20. *Gonomyia* (*Lipophleps*) *pervilis* sp. nov., venation.
21. *Ormosia diversipennis* sp. nov., venation.
22. *Cryptolabis* (*Bæoura*) *consocia* sp. nov., venation.
23. *Cryptolabis* (*Bæoura*) *lævilobata* sp. nov., venation.
24. *Molophilus celebesicus* sp. nov., venation.

PLATE 2

FIG. 25. *Tipula* (*Lunatipula*) *multibarbata* sp. nov., male hypopygium, details.
26. *Tipula* (*Lunatipula*) *multibarbata* sp. nov., male hypopygium, eighth sternite.
27. *Dolichopeza* (*Nesopeza*) *toala* sp. nov., male hypopygium, details.
28. *Dolichopeza* (*Nesopeza*) *profundemarginata* sp. nov., male hypopygium, details.
29. *Dolichopeza* (*Nesopeza*) *toraja* sp. nov., male hypopygium, details.
30. *Limonia* (*Libnotes*) *falsa* sp. nov., male hypopygium.
31. *Limonia* (*Limonia*) *alopecura* sp. nov., male hypopygium.
32. *Limonia* (*Limonia*) *inscita* sp. nov., male hypopygium.
33. *Helius* (*Helius*) *copiosus* sp. nov., male hypopygium.
34. *Orimarga* (*Orimarga*) *gymnoneura* sp. nov., male hypopygium.
35. *Orimarga* (*Orimarga*) *hypopygialis* sp. nov., male hypopygium.

PLATE 3

FIG. 36. *Epiphragma (Polyphragma) minahassana* sp. nov., male hypopygium.

37. *Limnophila (Tricholimnophila) ferocia* sp. nov., male hypopygium.
38. *Gonomyia (Lipophleps) mitophora* sp. nov., male hypopygium.
39. *Gonomyia (Lipophleps) pervilis* sp. nov., male hypopygium.
40. *Gonomyia (Lipophleps) gressitti* sp. nov., male hypopygium.
41. *Cryptolabis (Bæoura) consocia* sp. nov., male hypopygium.
42. *Cryptolabis (Bæoura) aliena* Alexander, male hypopygium.
43. *Cryptolabis (Bæoura) lævilobata* sp. nov., male hypopygium.
44. *Cryptolabis (Bæoura) trichopoda hassenensis* subsp. nov., male hypopygium.
45. *Molophilus celebesicus* sp. nov., male hypopygium.

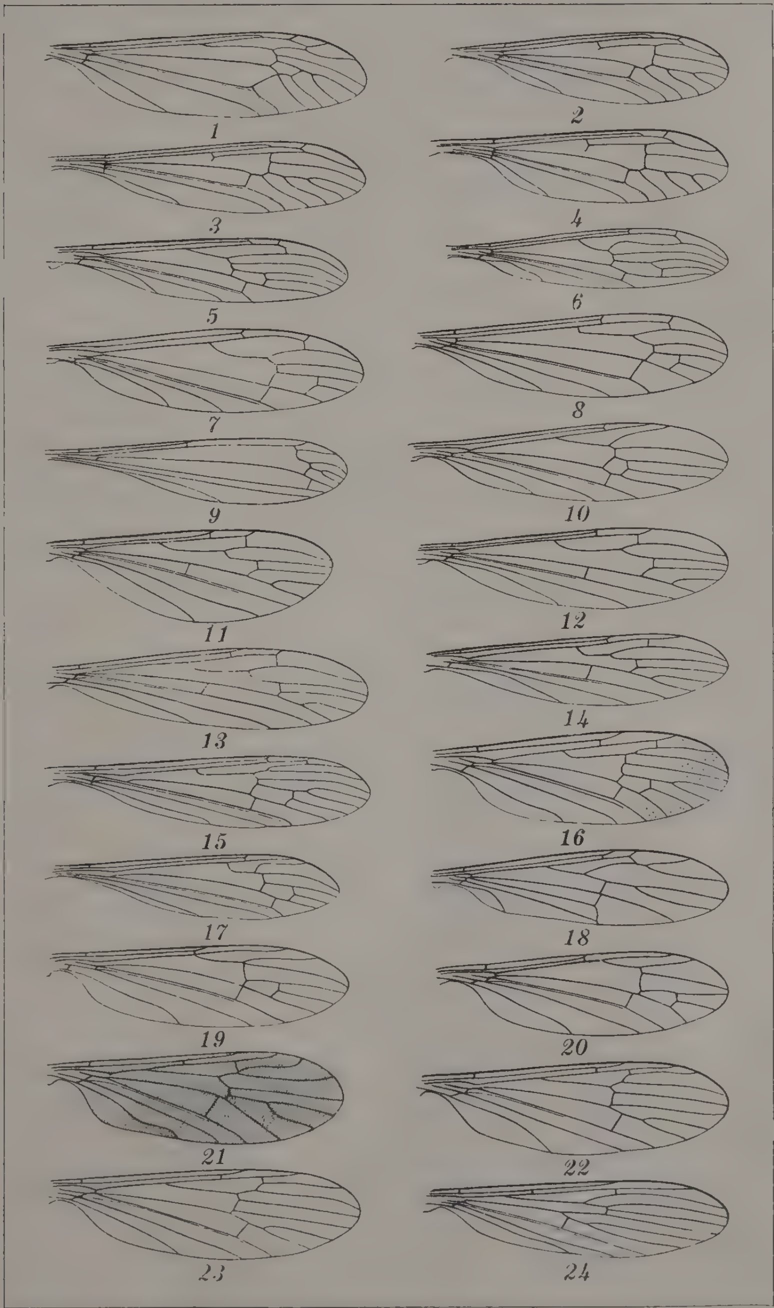

PLATE 1.

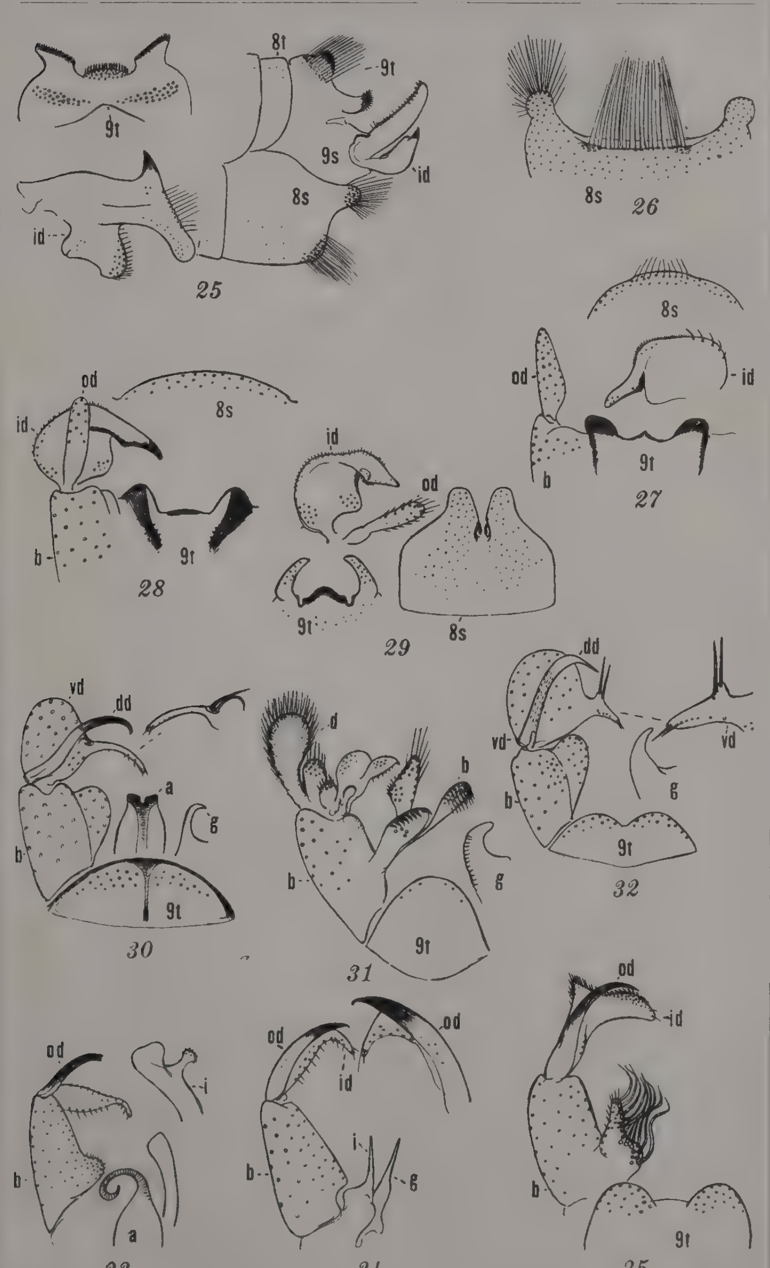
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PLATE 2.

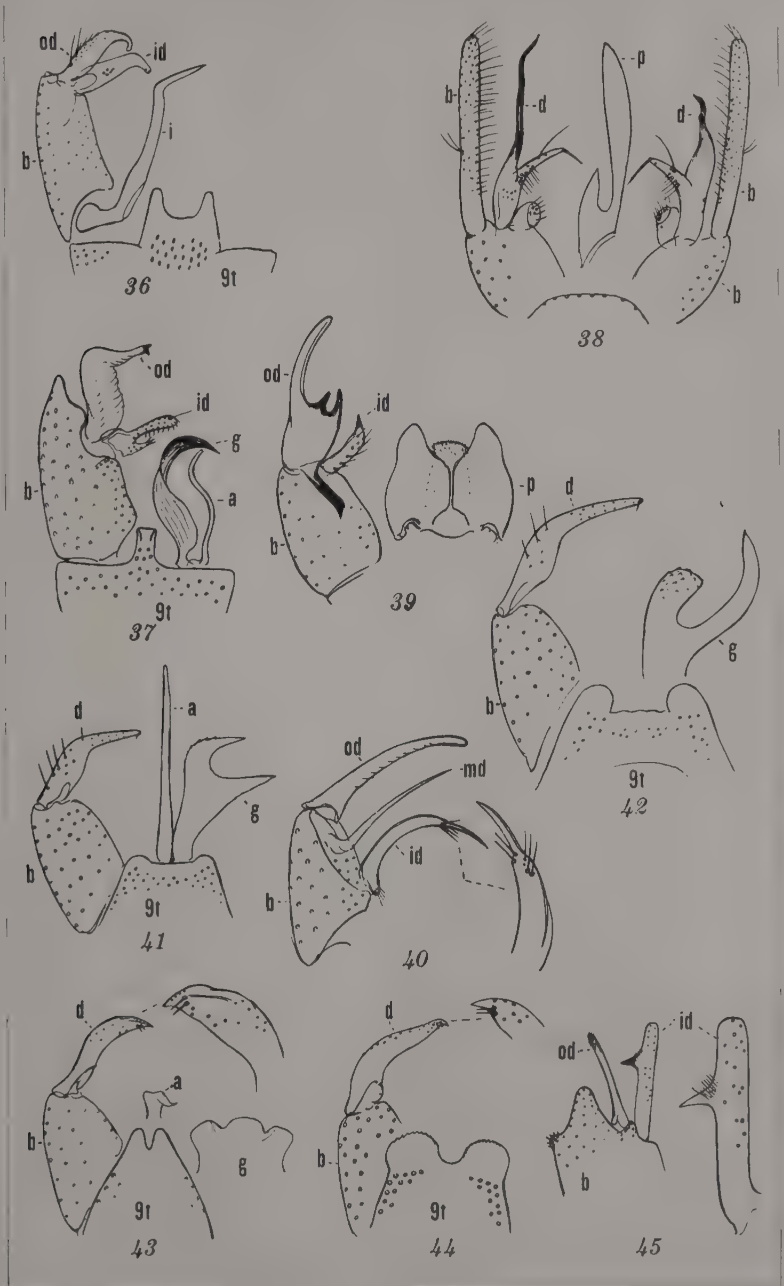

PLATE 3.

THE PHYSIOLOGY OF REPRODUCTION IN SWINE, III

PRELIMINARY STUDY OF THE MORPHOLOGY OF THE SPERMATOZOA [1]

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ONE PLATE

The presence of three different types of spermatozoa in the semen of the boar, the relative number of which is fairly constant, evokes considerable interest. They are distinguishable from one another by the absence or presence on the flagellum of a protoplasmic drop and by the position assumed by the drop on the tail. Measurements made of these types show that they also differ in size. On the significance of these different types, however, no information can be given here.

TYPES OF SPERMATOZOA

The spermatozoa of the boar are of three different types, which for present purposes may be designated I, II, and III, as on Plate 1.

The second type has the droplike protoplasmic structure attached on the proximal end of the middle piece, just below the neck, and the third has it at about the end of the upper third of the flagellum. This droplike structure appears to be a remnant of the cytoplasm of the differentiating spermatid. The first, which does not have the protoplasmic drop, is taken to be the normal type, largely because it ordinarily constitutes the greatest number in the semen.

The manner of attachment of the "drop" to the flagellum can best be studied by focusing the 4-mm objective up and down with the fine adjustment on a specimen that is still moving normally but relatively slowly. Such a specimen is suitable for study because no postmortem changes have set in, and because whether or not the "drop" surrounds the flagellum can be ade-

[1] This is the third paper of a series, the materials for which were worked out during the writer's stay in Soviet Russia.

quately observed. The difference in refractive index between the flagellum and the "drop" enables one to determine that the "drop" surrounds the flagellum completely. The flagellum is straight at the point where the "drop" is attached. In most specimens observed, the "drop" surrounded the tail symmetrically; in a few cases, however, symmetry is lacking.

The development of these types can be traced. If samples of spermatozoa are taken from the different parts of the epididymis, going from the proximal towards the distal portion, two facts become evident. First, the motility of the spermatozoa gradually increases as they move away from the proximal portion and approach the distal portion of the epididymis. In the proximal portion of the epididymis only nonmotile spermatozoa are encountered, while in the caudal portion only motile types are normally present. Second, most of the spermatozoa undergo a transformation from type II to type III, and finally to type I. From the proximal part of the epididymis only type II spermatozoa are present. As samples are taken towards the middle portion of the epididymis, type III soon makes its appearance, and gradually increases in number while type II correspondingly decreases. Finally type I appears, gradually becoming more numerous until it predominates over both types II and III. Not all spermatozoa, however, undergo the full process of transformation from type II to III and finally to I; some remain as type II and others as type III.

This phenomenon is not confined to the boar. Other workers, notably Hammar (1897) in the dog, Tournade and Regaud (1911) in the rat, Tournade (1913) in the rat, rabbit, guinea pig, and dog, and Young (1929) in the guinea pig, rat, ram, and bull, have observed that the spermatozoa removed from the proximal portion of the epididymis are nonmotile, or at most only slightly motile, while those removed from the posterior levels are motile.

Thus it appears that the spermatozoa undergo a sort of maturation in the epididymis and that type II is the most primitive form, III an intermediate form, and I the predominating type in the ordinary semen, the completely differentiated or matured type. From this standpoint both types II and III may be considered as immature types, type III being the more differentiated of the two.

On the other hand, if types II and III in the semen are immature—that is, not fully differentiated—two things are logically

to be expected; namely, (*a*) the proportion of types II and III to type I in the semen should increase in the course of intensive mating; and (*b*) there should be no distinct measurable differences among these types.

(*a*) *The relative proportions of the three types in intensively mated boars.*—The more intensively a boar is mated, the greater is the demand for the ejection of spermatozoa, and the shorter is the stay of the spermatozoa in the epididymis. During the early part of a period of intensive mating the normal expectation is for the ejection of type I and only a few of types II and III, if any. Now, in the first place the fact that the second mating in a day gives only a relatively meager number of spermatozoa, in spite of the presence in the epididymis of a greater number of spermatozoa than can be ejected in a number of ejections, was adduced in the first paper of this series as the basis for the suggestion that the spermatozoa need a certain minimum length of time in order to complete the process of transformation from the nonmotile type II to the motile types at the caudal portion of the epididymis. If this be so, one would expect that in the later part of a period of intensive mating—since there is less and less time for the transformation of the spermatozoa from types II and III to I—the proportion of immature gametes should increase with, at least in direct proportion to, the intensiveness of the mating and the progress of the period. Tables 1 to 3 show what takes place in the relative numbers of these various types as the boars are mated intensively.

TABLE 1.—*Relative numbers of the three types of spermatozoa of boars mated twice every other day.*

Boar No.	Time of day.	July 2.			July 3.			July 4.		
		I	II	III	I	II	III	I	II	III
2485/27	a. m.	436	5	59	(d)	(d)	(d)	465	------	35
	p. m.	467	5	28	(d)	(d)	(d)	500	------	------
2486/28	a. m.	422	1	77	(d)	(d)	(d)	486	1	13
	p. m.	428	4	68	(d)	(d)	(d)	492	------	8
2196/87	a. m.	------	(a)	------	------	(c)	------	------	(d)	------
	p. m.	------	(a)	------	270	145	85	------	(d)	------
1887/284	a. m.	------	(a)	------	355	43	102	------	(d)	------
	p. m.	------	(a)	------	------	(b)	------	------	(d)	------
2200/91	a. m.	------	(a)	------	130	302	68	------	(d)	------
	p. m.	------	(a)	------	------	(c)	------	------	(d)	------

[a] Not mated. [b] Did not mate. [c] No spermatozoa in secretion. [d] Rest.

TABLE 1.—*Relative numbers of the three types of spermatozoa of boars mated twice every other day*—Continued.

Boar No.	Time of day.	July 5.			July 6.			July 7.			July 8.		
		I	II	III	I	II	III	I	II	III	I	II	III
2485/27	a. m.	(d)	(d)	(d)	496	-----	4	(d)	(d)	(d)	500	-----	-----
	p. m.	(d)	(d)	(d)	500	-----	-----	(d)	(d)	(d)	499	-----	1
2486/28	a. m.	(d)	(d)	(d)	498	-----	2	(d)	(d)	(d)	494	3	3
	p. m.	(d)	(d)	(d)	475	6	19	(d)	(d)	(d)	496	1	3
2196/87	a. m.	461	16	23	-----	(d)	-----	471	16	13	-----	(a)	-----
	p. m.	500	-----	-----	-----	(d)	-----	-----	(b)	-----	-----	(a)	-----
1887/284	a. m.	418	7	75	-----	(d)	-----	-----	(b)	-----	-----	(a)	-----
	p. m.	491	-----	9	-----	(d)	-----	-----	(b)	-----	-----	(a)	-----
2200/91	a. m.	165	261	74	-----	(d)	-----	-----	(b)	-----	-----	(a)	-----
	p. m.	-----	(b)	-----	-----	(d)	-----	-----	(b)	-----	-----	(a)	-----

[a] Not mated. [b] Did not mate. [c] No spermatozoa in secretion. [d] Rest.

TABLE 2.—*Relative numbers of the three types of spermatozoa of boars mated once every day.*

Boar No.	June 21.			June 22.			June 23.		
	I	II	III	I	II	III	I	II	III
2564/34	------	(a)	------	500	------	------	500	------	------
2615/91	498	2	------	500	------	------	------	(b)	------
2805/330	------	(a)	------	362	121	17	452	42	6
Boar No.	**June 24.**			**June 25.**			**June 26.**		
	I	II	III	I	II	III	I	II	III
2564/34	500	------	------	500	------	------	495	5	------
2615/91	500	------	------	500	------	------	------	(b)	------
2805/330	490	10	------	500	------	------	493	7	------

[a] Not mated. [b] Did not mate.

TABLE 3.—*Relative numbers of the three types of spermatozoa in 10-month-old boars mated twice a day.*

Boar No.	Time of day.	June 28.			June 29.		
		I	II	III	I	II	III
2782/298	a. m.	477	4	19	------	(d)	------
	p. m.	------	(b)	------	------	------	------
2705/194	a. m.	497	1	2	------	(d)	------
	p. m.	------	------	------	------	(d)	------

[b] Did not mate. [d] Rest.

TABLE 3.—*Relative numbers of the three types of spermatozoa in 10-month-old boars mated twice a day*—Continued.

Boar No.	Time of day.	June 30.			July 1.			July 2.		
		I	II	III	I	II	III	I	II	III
2782/298	a. m.	484	7	9	------	(d)	------	------	(b)	------
	p. m.	480	4	16	------	------	------	------	(b)	------
2705/194	a. m.	489	------	11	------	(d)	------	------	(b)	------
	p. m.	494	------	6	------	------	------	------	(b)	------

[b] Did not mate. [d] Rest.

The counts were made from three slides prepared from the samples of semen soon after collection. The slides, made from semen well shaken and mixed, may be considered as constituting a good random sample of semen. From the spermatozoa in the preparations a random sample of 500 spermatozoa was taken. As each spermatozoon was come upon, it was classified according to type. In this manner the relative numbers of each of the three types were determined.

Tables 1 to 3 give the relative numbers of the three types of spermatozoa in the semen of boars under different intensivenesses of mating. Table 1 may be said to give the highest degree of intensiveness of mating. The boars in Table 1 being mated twice a day every other day did within twelve hours during the day of mating the work that the boars in Table 2 did in two days. As a general rule, the boars in Table 1, by doing the work at a faster rate, tired faster and took more time to get rested than the boars in Table 2. Moreover, at least in the case of boars 2485/27 and 2486/28, there were eight matings in the course of seven days or an average of over one mating a day; those in Table 2 mated only five times in as many days. Boar 2615/91 took five days for four matings.

As has been noted above, because the demand for spermatozoa is greatly increased during intensive mating over that during light mating, the relative proportion of types II and III to type I in the semen should increase, especially during the later part of an intensive-mating period. Tables 1 to 3 fail to satisfy this expectation. Table 1 shows instead, if anything, a tendency for the number of types II and III to decrease.

The tables further show that the different boars seem to possess different abilities to produce these different types. Boars 2564/34 and 2200/91 contrast in this respect. The former pro-

duced few of either type II or III—less than 0.5 per cent; on the other hand, boar 2200/91 is interesting in that his semen contained at one time a preponderance of type II over either type I or III, and even over both. The other boars examined show type I preponderating overwhelmingly over both types II and III.

The condition of the preponderance of type II over types I and III in the semen of boar 2200/91, July 3 and 5, was, however, a temporary condition, as Table 4 shows.

TABLE 4.—*Relative numbers of the three types in the semen of boar 2200/91 at different dates.*

Date.	Type.			Total spermatozoa.
	I	II	III	
July 3	130	302	68	1.83×10^{10}
July 5	165	261	74	239×10^{10}
August 15	477	11	12	11.07×10^{10}

In the case of this boar, at least, the big production of types II and III is associated with a small production of spermatozoa. July 3, even after a rest of thirteen days from his last mating, the boar gave only 1.83 by 10^{10} spermatozoa, and July 5, 2.39 by 10^{10}, almost double his production two days before, whereas August 15, after a rest of thirteen days, he gave 11.07 by 10^{10} spermatozoa. July 3 and 5, when the boar produced an abnormally small number of spermatozoa, types II and III were abnormally numerous, type II even predominated over types I and III. August 15, however, when he produced a normal number of spermatozoa, the relative number of types II and III was small. It would seem, therefore, as if the ejection of large numbers of types II and III were correlated with the production of abnormally small numbers of spermatozoa. In that case it is not improbable that the ejection of large numbers of types II and III is in some way due to an abnormal physiological condition in the boar.

This consideration raises the question of whether types II and III are abnormal. There are two facts that seem to contradict the idea that they are abnormal. First, their longevity is not less than that of type I. They have been observed actively and normally moving thirty-two hours after the collection of the semen, which was kept at 15° C. This is about as long as any type will live in vitro in undiluted semen at 15° C.

Second, abnormal products usually assume different shapes. As will presently be shown, measurements taken of the different types tend to show them to be distinct from one another and of little variability.

(*b*) *Measurements of the spermatozoa.*—Three hundred of each of the three types have been measured from the preparations by means of the ocular micrometer. The total length and the length and width of the head were the dimensions taken. In addition to these the distance from the tip of the acrosome to the "drop" was also taken in the case of type II. The individual spermatozoa measured were taken at random. The only selecting done was in picking out the individuals that were fairly straight; curled ones could not be measured accurately. The statistical treatment of the measurements is summarized in Table 5.

TABLE 5.—*Measurements of the three types of spermatozoa of the boar.*

Type.	Total length.		Distance from acrosome to "knob."	
	M. μ	S. D.	M. μ	S. D.
I	51.69±0.095	2.46±0.067		
II	50.93±0.084	2.16±0.059		
III	52.27±0.065	1.68±0.046	15.42±0.039	1.015+0.028

Type.	Head.			
	Length.		Breadth.	
	M. μ	S. D.	M. μ	S. D.
I	8.013±0.022	0.555±0.015	4.20±0.013	0.328±0.009
II	7.788±0.019	0.473±0.013	4.04±0.014	0.361±0.010
III	8.047±0.019	0.500±0.014	4.26±0.012	0.307±0.008

TABLE 6.—*Differences between the means of the three types of spermatozoa of the boar.*

Type.	Total length.	Head.	
		Length.	Breadth.
I–II	51.69—50.93 = 0.76± 0.128	8.913—7.788= 0.225±0.029	4.20—4.04 = 0.16±0.019
III–II	52.27—50.93 = 1.34± 0.106	8.047—7.788= 0.259±0.027	4.26—4.04 = 0.22±0.018
III–I	52.27—51.69 = 0.58± 0.116	8.047—8.013= 0.034±0.029	4.26—4.20 = 0.06±0.017

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Table 6, in which the significance of differences among the respective means are tested, shows that all the differences, except one—the exception being the difference between the length of head of types III and I—being more than three times their respective probable errors, may be considered at least almost certainly significant. According to the results type II is the smallest, type III the largest, and type I intermediate. Of course, the number measured is relatively small, and the smallness of the sample might invalidate the results obtained; but if each one of the samples could be considered a random sample the smallness of the numbers would not invalidate the results.

The results of the measurements are somewhat unexpected. If type II be the primitive type, as the evidence tends to show, then being the relatively undifferentiated type, it should be the largest; for some energy must be consumed in the process of differentiation, which would tend to reduce the size of the cells—unless the source of the energy needed for differentiation should be entirely of extra-cellular origin. There may possibly exist a mechanism that predestines the development of each spermatid into a particular type.

At all events, the evidence tends to show that these three types differ from one another not only in the absence or presence of a protoplasmic drop and on the position assumed by such a drop on the tail, but also in size. Furthermore, the variability of the different types is quite small, as gauged by their respective standard deviations.

There is no intergrading between types II and III. In other words, the protoplasmic drop seems to be either on the neck or towards the middle of the tail, but not in between. It seems then that there is no transformation from type II to type III in the semen; for were such a transformation taking place in the semen it should be possible to demonstrate it by showing that the curve of distribution of the protoplasmic drop is more or less a flat curve. The standard deviation of the measurement of the distance between the acrosome and the protoplasmic drop in type III would be large, and the position of the drop should vary all the way from the neck, its position in type II, to about the middle of the tail, its position in type III—which does not happen to be the case.

SUMMARY

1. The three types of spermatozoa observed in the semen of the boars studied represent morphological stages in their development. They differ from one another by the absence or presence of a protoplasmic drop and by the position assumed by the drop on the tail. Type I has no protoplasmic drop, type II has the drop on the neck, and type III towards the middle of the tail.

2. The spermatozoa are transformed from type II, which they all are at the proximal portion of the epididymis to type III, and finally to type I which is ordinarily the predominating type in the semen. Not all are transformed to type I, however; some of types II and III remain untransformed.

The transformation in type is parallelled by a transformation in motility. Type II found in the proximal portion of the epididymis are all nonmotile.

3. The relative numbers of the three types is not greatly altered by intensive mating.

4. Measurements made of representatives of types I, II, and III, tend to show that these types differ significantly in dimensions from one another. Type II is the smallest, III the largest, and I intermediate.

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ILLUSTRATION

PLATE 1. The three types of spermatozoa formed in the semen of the boar.

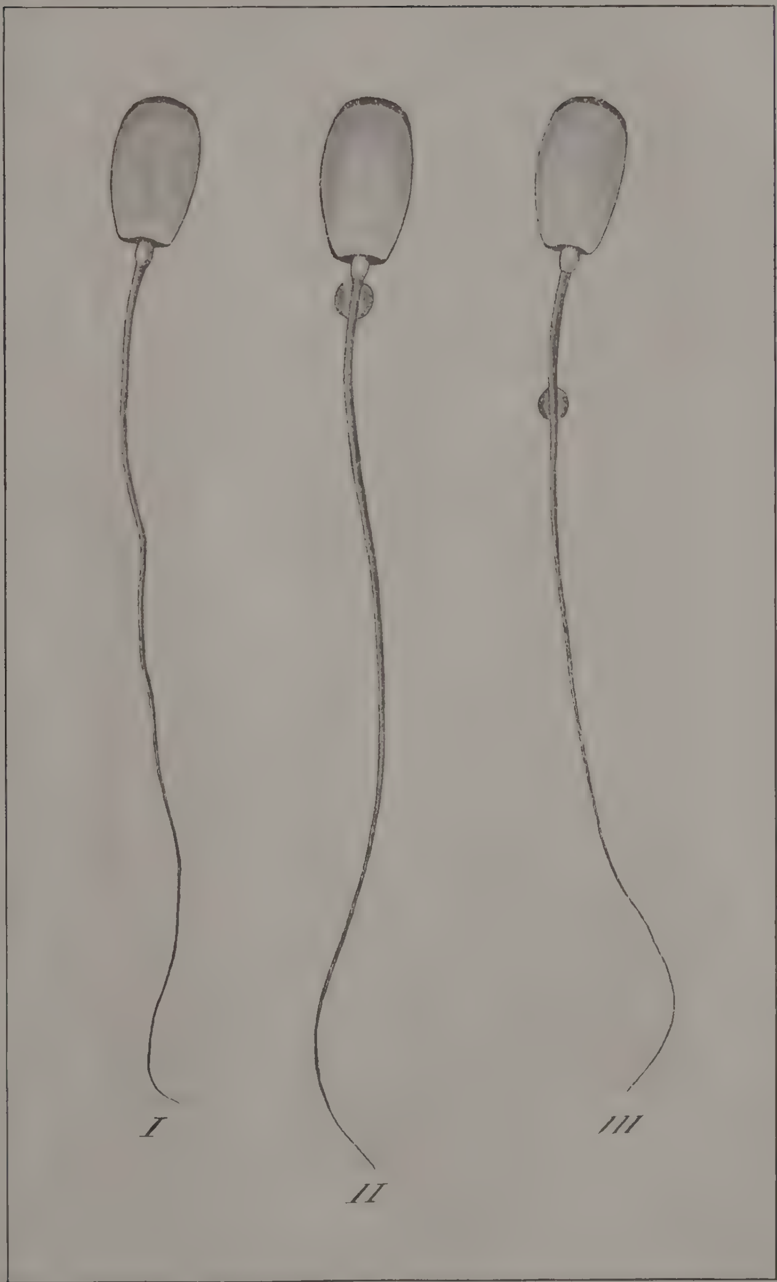

PLATE 1.

TANNIN CONTENT OF PHILIPPINE BARKS AND WOODS

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ONE PLATE

During 1931 the value of the leather and leather articles imported into the Philippines[1] amounted to 2,166,301 pesos. There are a number of tanneries in the Philippines and a considerable amount of leather is produced locally. In most of the tanneries the methods employed for tanning hides are rather antiquated and consequently much of the leather manufactured locally is of poor quality and has a disagreeable odor.

The Philippine methods of tanning and the quality of leather produced could be greatly improved by experimentation. With proper development of the Philippine leather industry it would not be necessary to import considerable quantities of leather. All the leather that is required for local consumption could be manufactured in the Philippines and quite likely an export trade could also be developed.

The first step in the improvement of the leather industry is the investigation of the available local tanning materials in order to determine which materials have the highest tannin content and are most efficient and economical.

In the Philippines the materials commonly used, at present, for tanning hides are the barks of the kamachíle tree [*Pithecolobium dulce* (Roxb.) Benth.] and various species of the mangrove (Rhizophoraceæ or mangrove family). Analyses of Philippine mangrove barks have been made by Bacon and Gana[2] and also by Williams.[3]

[1] Annual Report, Insular Collector of Customs, Manila (1933) 194.
[2] Philip. Journ. Sci. § A 4 (1909) 205.
[3] Philip. Journ. Sci. § A 6 (1911) 45.

In addition to mangrove Gana[4] also analyzed a few other Philippine barks. With the exception of kamachíle, these barks gave a rather low percentage of tannin and consequently the results were not promising.

Recently we determined the tannin content of a considerable number of Philippine barks and woods. Some of the barks were high in tannin and appeared to be of commercial value. Most of the woods, however, gave negative tests for tannin, although a few contained a very small amount.

The numerous samples of barks and woods selected for this investigation were taken, in general, from mature trees. Most of the trees were growing on Mount Maquiling near Los Baños in Laguna Province, though some were growing in other provinces.

Preparation of the samples for analysis consisted in first drying them in an oven at 60° C., for about twenty hours. The samples were then filed with a rasp and the filings sieved through a 20-mesh screen. The powder which passed through the sieve was used for the analysis.

Moisture determinations were made on the powdered samples and the results of the analyses were calculated on the moisture-free sample.

In analyzing the numerous samples we used a rapid method[5] for the determination of tannin. Results with high tannin barks were, however, checked by the official hide-powder method.

In Table 1 is given the tannin content of a considerable number of Philippine barks. As shown by the data some of them have a high percentage of tannin.

Kamachíle and the mangrove barks (bakáuan laláke, bakáuan babáe, tan͠gál, potótan, busáin, and lan͠garai) are used for tanning and naturally were found to have a considerable amount of tannin.

Samples of other barks (Table 1), which gave a high percentage of tannin, were analyzed by the official hide-powder method in the laboratory of the Philippine Cutch Corporation of Zamboanga through the courtesy of the manager, Mr. Geo. A. Kerr. The results are given in Table 2.

Pieces of hides were tanned very satisfactorily with infusions of these high-tannin barks. These tanning experiments were

[4] Philip. Journ. Sci. § A 10 (1915) 355.

[5] Baens, L., and A. P. West, Philip. Journ. Sci. 47 (1932) 467.

TABLE 1.—*Tannin content of Philippine barks.*

Sample. No.	Name of bark.		Tannin content.
	Common.	Scientific.	
			Per cent.
1	Bagtíkan	*Parashorea malaanonan* (Blco.) Merr.	3.60
6	Anabióng	*Trema orientalis* (L.) Bl.	17.10
7	Antipólo	*Artocarpus blancoi* (Elmer) Merr.	5.30
8	Balinhásai	*Buchanania arborescens* Bl.	11.10
9	Dúhat	*Eugenia cumini* (L.) Druce	0.90
10	Kalúmpit	*Terminalia edulis* Blco.	42.00
11	Sakat	*Terminalia nitens* Presl.	27.38
12	Santól	*Sandoricum koetjape* (Burm. f.) Merr.	11.80
13	White lauan	*Pentacme contorta* (Vid.) Merr. and Rolfe	5.50
14	Bitaog	*Calophyllum inophyllum* L.	19.12
15	Talúto	*Pterocymbium tinctorium* (Blco.) Merr.	10.20
16	Moláve	*Vitex parviflora* Juss.	trace
17	Anónang	*Cordia dichotoma* Forst. f.	1.80
18	Magílik	*Premna cumingiana* Schauer.	none
19	Balákat	*Zizyphus talanai* (Blco.) Merr.	none
20	Aiañgile	*Acacia confusa* Merr.	5.60
21	Agáru	*Dysoxylum decandrum* (Blco.) Merr.	none
22	Abúab	*Lophopetalum toxicum* Loher.	trace
23	Dapdáp	*Erythrina variegata* L.	none
24	Binúñga	*Macaranga tanarius* (L.) Muell.-Arg.	2.10
25	Himbabáo	*Allaeanthus luzonicus* (Blco.) F.-Vill.	trace
26	Liúsin	*Parinarium corymbosum* (Bl) Miq.	6.82
27	Vidal's lanútan	*Bombycidendron vidalianum* (Naves) Merr. and Rolfe.	none
28	Tuái	*Bischofia javanica* Bl.	trace
29	Sablót	*Litsea glutinosa* (Lour.) C. B. Rob.	0.60
30	Kaliantan	*Leea manillensis* Walp.	11.80
31	Ákle	*Albizzia acle* (Blco.) Merr.	1.80
32	Haulli	*Ficus hauili* Blco.	none
33	Tíbig	*Ficus nota* (Blco.) Merr.	1.10
34	Malarúhat	*Eugenia similis* Merr.	4.20
35	Láñgil	*Albizzia lebbeck* (L.) Benth.	6.50
36	Rosewood	*Dalbergia sissoo* Roxb.	1.00
37	Binúang	*Octomeles sumatrana* Miq.	2.60
38	Guava	*Psidium guajava* L.	11.30
39	Kúpang	*Parkia javanica* (Lam.) Merr.	20.50
40	Mango	*Mangifera indica* L.	9.40
41	Kariskis	*Pithecolobium subacutum* Benth.	21.90
42	Kamachíle	*Pithecolobium dulce* (Roxb.) Benth.	30.10
43	Banabá	*Lagerstroemia speciosa* (L.) Pers.	2.20
44	Bayok-bayokan	*Pterospermum niveum* Vid.	9.80
45	Caudate leaf oak	*Quercus philippinensis* A. DC.	7.70
46	Kalamansánai	*Neonauclea calycina* (Bartl.) Merr.	trace
47	Kulatíñgan	*Pterospermum obliquum* Blco.	19.00
48	Lamóg	*Planchonia spectabilis* Merr.	4.50
49	Pagsahiñgin	*Canarium villosum* (Bl.) F.-Vill.	0.20
50	Bakáuan babáe	*Rhizophora mucronata* Lam.	28.50
51	Bakáuan laláke	*Rhizophora candelaria* DC.	20.20
52	Potótan	*Bruguiera sexangula* (Lour.) Poir.	24.50

TABLE 1.—*Tannin content of Philippine barks*—Continued.

Sample No.	Name of bark.		Tannin content.
	Common.	Scientific.	
			Per cent.
56	Busáin	*Bruguiera conjugata* (L.) Merr	30.70
58	Lañgarai	*Bruguiera parviflora* (Roxb.) W and A	25.00
60	Tañgál	*Ceriops tagal* (Perr.) C. B. Rob	27.20
63	Dalinsi	*Terminalia pellucida* Presl	17.80
64	Akleng-parang	*Albizzia procera* (Roxb.) Benth	14.60
106	Indian rosewood	*Dalbergia latifolia* Roxb	none
107	Ipil	*Intsia bijuga* (Colebr.) O. Ktze	4.60
108	Talísai	*Terminalia catappa* L	1.70
112	Javanese cañafistula	*Cassia javanica* L	6.30
113	Kalantás	*Toona calantas* Merr. and Rolfe	1.60
115	Baringbíng	*Peltophorum inerme* (Roxb.) Llanos	11.50
117	Tabígi	*Xylocarpus granatum* Koen	22.50
119	Teak	*Tectona grandis* L. f	none
137	Black wattle	*Acacia decurrens* Willd	42.50

TABLE 2.—*Analysis of Philippine tanbarks of high tannin content.*[a]

Bark.	Tannin.	Non-tannin.	Solids.		
			Total.	Soluble.	Insoluble.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Kalúmpit; *Terminalia edulis* Blco	34.11	7.23	43.17	41.34	1.83
Sakat; *Terminalia nitens* Presl	19.46	6.49	28.66	25.95	2.71
Kariskis; *Pithecolobium subacutum* Benth	19.70	7.63	28.12	27.33	0.79
Kúpang; *Parkia javanica* (Lam.) Merr	18.07	8.37	27.82	26.44	1.38
Bitaog; *Calophyllum inophyllum* L	16.05	4.96	22.68	21.01	1.67
Black wattle; *Acacia decurrens*; thickness of bark:					
1/16 inch	.3	10.72	40.16	39.15	1.01
1/4 inch	45.80	10.60	56.80	56.18	0.62
1/4 inch	45.05	10.73	56.58	55.78	0.80
5/16 inch	45.79	10.75	57.28	56.54	0.74

[a] Analysis made under the direction of Mr. Geo. A. Kerr in the laboratory of the Philippine Cutch Corporation of Zamboanga.

carried out in our laboratory and also in the laboratory of the Philippine Cutch Corporation at Zamboanga.

In his report to us Mr. Kerr writes as follows:

The sample of kalúmpit bark (Table 2) contains sufficient tannin to indicate that it may be commercially valuable for the manufacture of tannin extract or for direct use in the tannery. The bark samples of

sakat, kariskis, kúpang, and bitaog may be suitable for direct use in the tannery but the tannin content is not high enough to warrant utilization for making tannin extract.

The black wattle bark gave the highest tannin content (Tables 1 and 2) of all the barks we analyzed. This bark was obtained from trees grown in Bukidnon Province, Mindanao. In the place (sitio) called Kaatoan these trees reached an average height of 5.29 meters in about four years. They were cultivated from seeds that were obtained from the Forest Research Institute, Buitenzorg, Java.

Concerning the analysis and commercial value of the Philippine black wattle bark grown in Bukidnon, Mr. Kerr says:

> This bark compares most favorably with the native black wattle bark of Australia and also the plantation bark of Natal and Kenya Colonies, Africa. In fact, the tannin content is considerably higher than the average in those countries and the nontannin content is also good. The color and tannage is about equal to any other bark we have examined. There is no question that, if bark like this could be grown in Bukidnon, there is a very great future for it. Although wattle bark is not used in America to any great extent it is very extensively imported into Europe and Great Britain where, at present, the normal price is from $35 to $40 per ton of dry bark.

Mr. Arthur F. Fischer, director of the Philippine Bureau of Forestry, informs us that in some districts in Bukidnon the black wattle tree grows very well and it is quite likely that these trees could be cultivated successfully on rich soil where the climate is similar to that of Bukidnon.

Since 1824 black wattle bark has been used in Australia and Tasmania as tanning material.[6] It was introduced into Natal, South Africa, about 1864. It is now cultivated in other districts in Africa and is considered one of the richest tanning materials known. The bark gives an infusion of good color so that the resulting leather is very light and has only a faint pinkish tinge. Owing to the high proportion of tannin it is a cheap tanning material and the bark can be stored a long time without any appreciable deterioration. Specimens of bark stored in the Sydney Technological Museum for thirty years were analyzed before and after storage. The results showed practically no diminution in the tannin content.

[6] Williams, C. O., Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932).

C. O. Williams[7] made a very thorough investigation of the black wattle trees grown in the Wartburg district of Natal, South Africa. These trees gave a fairly good yield of bark. Unfertilized trees (four and a half years old) gave 3.23 tons of green bark per acre while well-fertilized trees gave 5.04 tons.

Black wattle trees (four years old) produced in Natal, Africa, a bark containing 31.5 per cent of tannin, while in the Philippines the bark had 45 per cent. From this it appears that, under favorable growing conditions, black wattle bark gives a higher yield of tannin in the Philippines than in Africa.

The development of Philippine plantations of black wattle trees would seem to offer promising prospects. After stripping the trees of the bark the wood that remains may be used for various purposes. According to C. O. Williams[8] the chief by-product of the wattle-bark industry in Natal, Africa, is the wood. He estimated that out of the total receipts from an ordinary Natal wattle plantation, about 56 per cent was derived from the sale of the bark, 33 per cent from mine props, and 11 per cent from fuel wood. It is therefore realized that the timber in itself is a valuable source of income as compared with that derived from the bark. He says it would be difficult to find any tanning material that could be produced in South Africa in such quantity and at such low cost as to compete successfully with wattle bark.

In Table 3 is given the percentage of tannin in some Philippine barks obtained from different localities. As shown by the data the tannin content of the bark from trees of the same species grown in different districts varies considerably. In the report of his work on Philippine mangrove barks R. R. Williams[9] states:

> It has further been observed that, in general, the tannin content of the bark increases with the size of the tree. It is probable that the age rather than the size of the tree is the true coefficient of the tannin content but since these trees show no seasonal rings of growth it is almost impossible more than roughly to approximate the age.

[7] Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932).

[8] Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932) 62 and 88.

[9] Philip. Journ. Sci. § A 6 (1911) 45.

TABLE 3.—*Tannin content of some Philippine barks from different localities.*

Sample No.	Name of bark.		Place of collection.	Tannin content.
	Common.	Scientific.		
				Per cent.
99	Anabióng	*Trema orientalis* (L.) Bl	Alisongsong Lallo, Cagayan	23.20
53	do	do	Tayabas	9.50
77	do	do	Cabanatuan, Nueva Ecija	10.70
91	do	do	Masinloc, Zambales	81.90
93	do	do	Subic, Zambales	6.50
71	do	do	Hermosa, Bataan	10.60
73	do	do	Limay, Bataan	11.20
6	do	do	Los Baños, Laguna	17.10
54	Bakáuan babáe	*Rhizophora mucronata* Lam	Tayabas	18.00
131	do	do	Puerto Princesa, Palawan	11.80
109	do	do	Palawan	22.50
55	Bakáuan laláke	*Rhizophora candelaria* DC	Tayabas	16.00
132	do	do	Puerto Princesa, Palawan	9.20
110	do	do	Palawan	17.90
103	Bitaog	*Calophyllum inophyllum* L	Jurisdiction Lallo, Cagayan	16.50
65	do	do	Pangasinan	16.20
82	do	do	Vigan Forest Station, Ilocos Sur.	5.30
92	do	do	Masinloc, Zambales	11.60
94	do	do	Subic, Zambales	17.30
121	do	do	Limay, Bataan	9.00
14	do	do	Los Baños, Laguna	19.12
56	Busáin	*Bruguiera conjugata* (L.) Merr.	Tayabas	30.70
133	do	do	Puerto Princesa, Palawan	12.60
111	do	do	Palawan	19.30
66	Kalúmpit	*Terminalia edulis* Blco	Pangasinan	16.10
83	do	do	Vigan Forest Station, Ilocos Sur.	22.50
88	do	do	Bayombong, Nueva Vizcaya	25.90
62	do	do	Tayabas	24.80
78	do	do	Cabanatuan, Nueva Ecija	36.20
95	do	do	Subic, Zambales	32.10
124	do	do	Masinloc, Zambales	11.40
72	do	do	Hermosa, Bataan	23.30
74	do	do	Limay, Bataan	11.70
10	do	do	Los Baños, Laguna	42.00
70	Kamachile	*Pithecolobium dulce* (Roxb.) Benth.	Bucay, Abra	35.20
67	do	do	Pangasinan	33.00
89	do	do	Bayombong, Nueva Vizcaya	30.20
57	do	do	Tayabas	25.20
79	do	do	Cabanatuan, Nueva Ecija	37.20
125	do	do	Masinloc, Zambales	16.00
96	do	do	Subic, Zambales	12.20
122	do	do	Limay, Bataan	20.40
42	do	do	Los Baños, Laguna	30.10

TABLE 3.—*Tannin content of some Philippine barks from different localities*—Continued

Sample No.	Name of bark. Common.	Name of bark. Scientific.	Place of collection.	Tannin content.
				Per cent.
104	Kariskis	*Pithecolobium subacutum* Benth.	Naguilian Lallo, Cagayan	27.70
68	do	do	Pangasinan	6.80
80	do	do	Cabanatuan, Nueva Ecija	23.50
126	do	do	Masinloc, Zambales	5.20
97	do	do	Subic, Zambales	10.60
41	do	do	Los Baños, Laguna	21.90
100	Kulatiñgan	*Pterospermum obliquum* Blco.	Alisongsong Lallo, Cagayan	16.70
86	do	do	Caniaw, Bantay, Ilocos Sur	28.80
61	do	do	Tayabas	7.20
75	do	do	Limay, Bataan	27.60
47	do	do	Los Baños, Laguna	19.00
129	Kúpang	*Parkia javanica* (Lam.) Merr.	Mount Banahaw, Tayabas	9.70
127	do	do	Masinloc, Zambales	12.70
98	do	do	Subic, Zambales	6.50
123	do	do	Limay, Bataan	21.40
39	do	do	Los Baños, Laguna	20.50
58	Lañgarai	*Bruguiera parviflora* (Roxb.) W. and A.	Tayabas	25.00
134	do	do	Puerto Princesa, Palawan	11.50
114	do	do	Palawan	13.10
59	Potótan	*Bruguiera sexangula* (Lour.) Poir.	Tayabas	20.50
135	do	do	Puerto Princesa, Palawan	18.90
116	do	do	Palawan	18.90
101	Sakat	*Terminalia nitens* Presl	Alisongsong Lallo, Cagayan	14.60
102	do	do	Aggutan Gattara, Cagayan	27.60
69	do	do	Pangasinan	18.70
84	do	do	Vigan Forest Station, Ilocos Sur.	9.50
90	do	do	Bayombong, Nueva Vizcaya	44.00
128	do	do	Masinloc, Zambales	22.00
120	do	do	Hermosa, Bataan	29.50
130	do	do	Maligaya Unisan, Tayabas	12.80
81	do	do	Cabanatuan, Nueva Ecija	21.80
76	do	do	Limay, Bataan	33.50
11	do	do	Los Baños, Laguna	27.38
60	Táñgal	*Ceriops tagal* (Perr.) C. B. Rob.	Tayabas	27.20
136	do	do	Puerto Princesa, Palawan	27.50
118	do	do	Palawan	28.10

In the Wartburg district [10] of Natal, South Africa, the average tannin content of black wattle bark from trees 2 years old

[10] Williams, C. O., Union of South Africa, Dept. Agr., Science Bull. No. 106 (1932).

was found to be 26.3 per cent and from trees 12 years old it was 39.8 per cent. Ten years in the age of these trees increased the average tannin content of the bark only 13.5 per cent.

According to our data (Table 3) a bark of a certain species may give a rather high percentage of tannin in one province and a very low percentage in another. Since the barks used for these analyses had about the same thickness this difference in tannin content is too great to be due only to the age of the bark. Apparently the local environmental conditions of tree growth affect considerably the tannin content of the bark.

Our results (Table 3) are interesting for they indicate certain places that are very suitable for growing trees with high-tannin bark. For instance anabióng (sample 91), grown in Masinloc, Zambales, produces bark with a higher-tannin content (31.9 per cent) than when grown in other locations. Anabióng is a fast-growing tree and reaches a diameter of about 10 centimeters in two years. It requires very little labor to obtain the bark as it is easily removed from the tree, and consequently it might be profitable to cultivate anabióng in Zambales.

Kalúmpit bark gave a tannin content of 42 per cent when the trees were grown at Los Baños, Laguna. Sakat bark, grown at Bayombong, Nueva Vizcaya, had 44 per cent of tannin. These barks gave a much lower tannin content when the trees were grown in other districts.

In order to ascertain the most desirable places for growing trees with high-grade tanbark, it would be advisable to cultivate the trees in various locations in the different provinces.

The simplest classification of tannins divides them into two main groups—pyrogallol and catechol tannins. These two classes of tannins may be distinguished by their reactions with certain chemical reagents such as ferric chloride, sulphuric acid, bromine water, and lead acetate with the subsequent addition of acetic acid.

We tested the high-tannin barks for the kind of tannin contained in them. Extracts of black wattle, kariskis, kulatiñgan, bitaog, anabióng, kamachíle, tabígi, and the mangrove barks, gave reactions characteristic of catechol tannins. The dalinsi extract contained pyrogallol tannins. Infusions of kalúmpit, sakat, and kúpang, contained principally pyrogallol tannins, though they also had small amouts of catechol tannins.

A considerable number of Philippine woods were analyzed for their tannin content. Most of the woods gave negative results or only traces of tannin. A few, however, were found to have

small amounts of tannin. The names of woods which contained tannin are given in Table 4, and in Table 5 are given the names of those which gave negative results or only traces of tannin.

TABLE 4.—*Tannin content of some Philippine woods.*

Sample. No.	Name of wood.		Tannin content.
	Common.	Scientific.	
			Per cent.
19	Lamóg	*Planchonia spectabilis* Merr.	0.50
23	Biñgas	*Terminalia comintana* (Blco.) Merr.	1.40
25	Bayók	*Pterospermum diversifolium* Bl.	2.20
33	Palong manok	*Alangium chinense* (Lour.) Rehder	0.80
43	Apítong	*Dipterocarpus grandiflorus* Blco.	0.30
45	Oak	*Quercus bennettii* Miq.	0.50
53	Kalúmpit	*Terminalia edulis* Blco.	2.90
82	Bitoñgol	*Flacourtia rucam* Zoll. and Merr.	1.90
90	Dúñgon-láte	*Heritiera littoralis* Dry.	2.10
92	Tañgíle	*Shorea polysperma* (Blco.) Merr.	1.80
118	Javanese cañafistula	*Cassia javanica* L.	1.20

In addition to our experiments on tanbarks and woods we have also tested some green (unripe) fruits for their tannin content. We found two fruits that seemed to offer promising prospects for making commercial tannin extract. The fruit of sakat (*Terminalia nitens*) gave 29.57 per cent of tannin. Tanning experiments with the extract of this fruit gave about the same results as those obtained with the extract of the fruit of myrobalan (*Terminalia chebula*) which is considered a very good tanning material and contains about 30 to 40 per cent of tannin.

The kernels of some betel nuts [11] gave 26.89 per cent of tannin. The extract from these kernels appeared to be excellent tanning material and gave leather which had a pale cream color. We intend to make tanning tests on the various species of betel nuts and other Philippine fruits when time permits.

We are now preparing to install in the Bureau of Science a miniature tannin extract plant and tannery. We expect to make extracts from the more promising Philippine tanbarks and fruits and to use these extracts for making leather according to the modern technique of tanning. The operation of these plants and the results obtained should be of very practical value to

[11] *Areca catechu* L. Varietal determination was not made for lack of botanical material.

TABLE 5.—*Philippine woods which contain no tannin or only traces of tannin.*

Sample No.	Name of wood.	
	Common.	Scientific.
1	Bagtíkan	*Parashorea malaanonan* (Blco.) Merr.
7	Bolongéta	*Diospyros pilosantera* Blco.
8	Balakat-gúbat	*Sapium luzonicum* (Vid.) Merr.
9	Santól	*Sandoricum koetjape* (Burm. f.) Merr.
10	Anúbing	*Artocarpus cumingiana* Trec.
11	Balákat	*Zizyphus talanai* Blco.
12	Balóbo	*Diplodiscus paniculatus* Turcz.
13	Malaikmo	*Celtis philippinensis* Blco.
14	Alupág	*Euphoria cinerea* Radlk.
15	Banai-bánai	*Radermachera pinnata* (Blco.) Seem.
16	Dulit	*Canarium multipinnatum* Llanos.
17	Benguet pine	*Pinus insularis* Endl.
20	Kayatau	*Dysoxylum turczaninowii* C. DC.
21	Kariskis	*Pithecolobium subacutum* Benth.
22	Lago	*Pygeum vulgare* (Koehne) Merr.
24	Bayánti	*Aglaia llanosiana* C. DC.
26	Kulatingan	*Pterospermum obliquum* Blco.
27	Bolon	*Alphonsea arborea* (Blco.) Merr.
28	Balsa	*Ochroma lagopus* Schwartz.
29	Nárra	*Pterocarpus indicus* Willd.
30	Ilang-ilang	*Canangium odoratum* (Lam.) Baill.
31	Anabióng	*Trema orientalis* (L.) Bl.
32	Fire-tree	*Delonix regia* (Boj.) Raf.
34	Alím	*Melanolepis multiglandulosa* (Reinw.) Reichb. f. and Zoll.
35	Baguilúmbang	*Aleurites trisperma* Blco.
36	Gúbas	*Endospermum peltatum* Merr.
37	Lúmbang	*Aleurites moluccana* (L.) Willd.
38	Malapapáya	*Polycias nodosa* (Bl.) Seem.
39	Rain tree	*Samanea saman* (Jacq.) Merr.
40	Basikong	*Ficus conora* King.
41	Binunga	*Macaranga tanarius* (L.) Muell.-Arg.
42	Tibig	*Ficus nota* (Blco.) Merr.
44	Gatásan	*Garcinia venulosa* (Blco.) Choisy.
46	Camagón	*Diospyros discolor* Willd.
47	Tanglín	*Adenanthera intermedia* Merr.
48	Tináan-pantái	*Cyclostemon bordenii* Merr.
49	Amúgis	*Koordersiodendron pinnatum* (Blco.) Merr.
50	Naríg	*Vatica manggachapoi* Blco.
51	Tuái	*Bischofia javanica* Bl.
52	Kalúkoi	*Ficus malunuensis* Warb.
54	Tamayuán	*Strombosia philippinensis* (Baill.) Rolfe.
55	Bayok-bayókan	*Pterospermum niveum* Vid.
56	Gisok	*Shorea balangeran* (Korth.) Dyer.
57	Salakin	*Aphanamixis cumingiana* (C. DC.) Harms.
58	Terukan	*Beilschmiedia glomerata* Merr.
59	Butli	*Ficus manilensis* Warb.
60	Bingábing	*Macaranga grandifolia* (Blco.) Merr.
61	Sanglai	*Ahernia glandulosa* Merr.
62	Hamingdáng	*Macaranga bicolor* Muell.-Arg.
63	Ibaibáan	*Glochidion philippicum* (Cav.) C. B. Rob.
64	Apanang	*Neotrewia cumingii* (Muell.-Arg.) Pax and Hoffm.

TABLE 5.—*Philippine woods which contain no tannin or only traces of tannin*—Continued.

Sample No.	Name of wood.	
	Common.	Scientific.
65	Pakíling	*Ficus odorata* (Blco.) Merr.
66	Katong-maching	*Chisocheton pentandrus* (Blco.) Merr.
67	Iloilo	*Aglaia iloilo* (Blco.) Merr.
68	Malasangkí	*Euonymus javanicus* Bl.
69	Tañgisang-bayáuak	*Ficus variegata* Bl.
70	Náto	*Palaquium luzoniense* (F.-Vill.) Vid.
71	Kamátog	*Erythrophloeum densiflorum* (Elm.) Merr.
72	Guijo	*Shorea guiso* (Blco.) Bl.
73	Mangachapuy	*Hopea acuminata* Merr.
74	Palosápis	*Anisoptera thurifera* (Blco.) Bl.
75	Rarang	*Erythrina subumbrans* (Hassk.) Merr.
76	Tambalau	*Knema glomerata* (Blco.) Merr.
78	Villamil's nato	*Sideroxylon villamilii* Merr.
79	Pahútan	*Mangifera altissima* Blco.
80	Bugáuak	*Evodia confusa* Merr.
81	Tanghau	*Astrocalyx calycina* (Vid.) Merr.
83	Lanútan	*Polyalthia rumphii* (Bl.) Merr.
84	Balitahan	*Bridelia glauca* Bl.
85	Malanángka	*Parartocarpus woodii* (Merr.) Merr.
86	Almon	*Shorea eximia* (Miq.) Scheff.
87	White lauan	*Pentacme contorta* (Vid.) Merr. and Rolfe.
88	Yakál	*Hopea plagata* (Blco.) Vid.
89	Mayápis	*Shorea palosapis* (Blco.) Merr.
91	Malúgai	*Pometia pinnata* Forst.
93	Ákle	*Albizzia acle* (Blco.) Merr.
94	Bitaog	*Calophyllum inophyllum* L.
95	Banabá	*Lagerstroemia speciosa* (L.) Pers.
96	Ceara rubber	*Manihot glaziovii* Muell.-Arg.
97	Únik	*Albizzia chinensis* (Osbeck) Merr.
98	Ípil	*Intsia bijuga* (Colebr.) O. Ktze.
99	Indian rosewood	*Dalbergia latifolia* Roxb.
100	Lanete	*Wrightia laniti* (Blco.) Merr.
101	Láñgil	*Albizzia lebbeck* (L.) Benth.
102	Liúsin	*Parinarium corymbosum* (Bl.) Miq.
103	Moláve	*Vitex parviflora* Juss.
104	Taiñgang babui	*Gonocaryum calleryanum* (Baill.) Becc.
105	Pagsahíñgin	*Canarium villosum* (Bl.) F.-Vill.
106	Pañgi	*Pangium edule* Reinw.
107	Sibukáu	*Caesalpinia sappan* L.
108	Talísai	*Terminalia catappa* L.
109	Tíndalo	*Pahudia romboidea* (Blco.) Prain.
110	Aiañgile	*Acacia confusa* Merr.
111	Teak	*Tectona grandis* L. f.
112	Kalantás	*Toona calantas* Merr. and Rolfe.
113	Mahogany	*Swietenia mahagoni* Jacq.
114	Banúyo	*Wallaceodendron celebicum* Koord.
115	West Indian cedar	*Cedrela odorata* L.
116	Vidal's lanútan	*Bombycidendron vidalianum* (Naves) Merr. and Rolfe.
117	Baringbíng	*Peltophorum inerme* (Roxb.) Llanos.

those interested in the Philippine tanning industry and should serve to improve the quality of leather manufactured locally. Moreover the production of tannin extracts on a small commercial scale may eventually lead to an export trade in this industry.

In their reforestation work the Bureau of Forestry is planning to cultivate in certain districts trees with high-tannin bark.

SUMMARY

The tannin content of numerous Philippine barks was determined. Kamachíle and the mangrove barks (bakáuan babáe, bakáuan laláke, tañgal, potótan, busáin, and lañgarai) are used for tanning and naturally were found to have a considerable amount of tannin.

Other barks which had a rather high percentage of tannin were kalúmpit, sakat, kariskis, kúpang, and bitaog. These barks may be suitable for direct use in the tannery, but, with the exception of kalúmpit, the amount of tannin is not high enough to warrant utilization for making tannin extract.

The black wattle bark gave the highest tannin content of all the barks we analyzed. Bark from trees four years old contained about 45 per cent of tannin. Excellent tannin extract may be made from this bark.

The black wattle tree grows well in Bukidnon and probably it could be cultivated successfully elsewhere in the Islands where the climate is similar to that of Bukidnon. The development of Philippine plantations of black wattle trees would seem to offer promising prospects. After stripping the trees of the bark the wood that remains may be used for various purposes, such as mine timber, fuel, and the manufacture of paper and charcoal.

When trees of the same species are grown in different localities the amount of tannin in the bark may vary a great deal. This difference in tannin content is often too great to be due only to the age of the bark. Apparently the local environmental conditions of tree growth affect considerably the tannin content of the bark. For certain tree species our results (Table 3) suggest some districts that are more suitable than others for producing high-tannin bark.

In order to ascertain the most desirable places for growing trees with high-grade tanbark it would be advisable to cultivate

the trees experimentally in various locations in the different provinces.

A considerable number of Philippine woods were tested for tannin. Although a few of these woods contained a small amount of tannin, most of them had no tannin or only traces of it.

We also investigated a few Philippine fruits. Sakat (*Terminalia nitens*) and some betel nuts gave very good tannin extracts.

We are preparing to install in the Bureau of Science a miniature tannin-extract plant and tannery. Extracts obtained from Philippine tanbarks and fruits will be used in making leather.

The Bureau of Forestry is planning to reforest certain districts with trees having bark of high-tannin content.

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To Mr. Mamerto D. Sulit, of the Philippine Bureau of Forestry, obligations are acknowledged for checking the scientific names of the barks and trees recorded in this paper.

ILLUSTRATION

PLATE 1

Black wattle tree (*Acacia decurrens*) grown in Bukidnon, Mindanao.

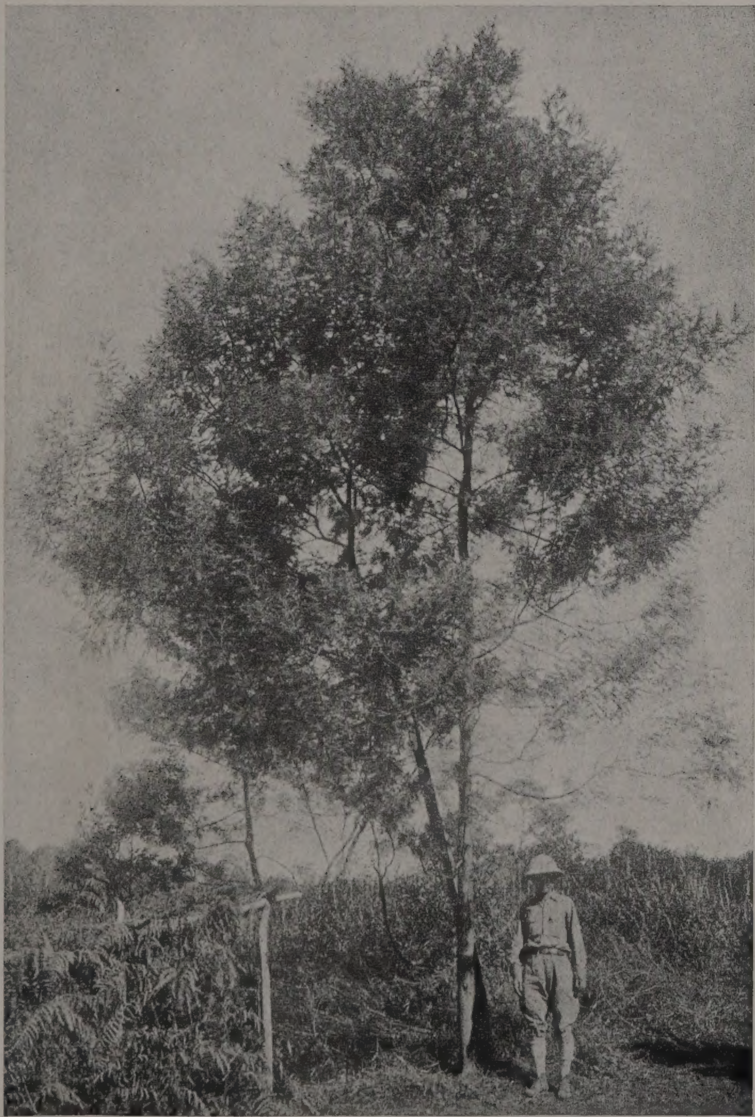

PLATE 1.